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Engineering News-Record

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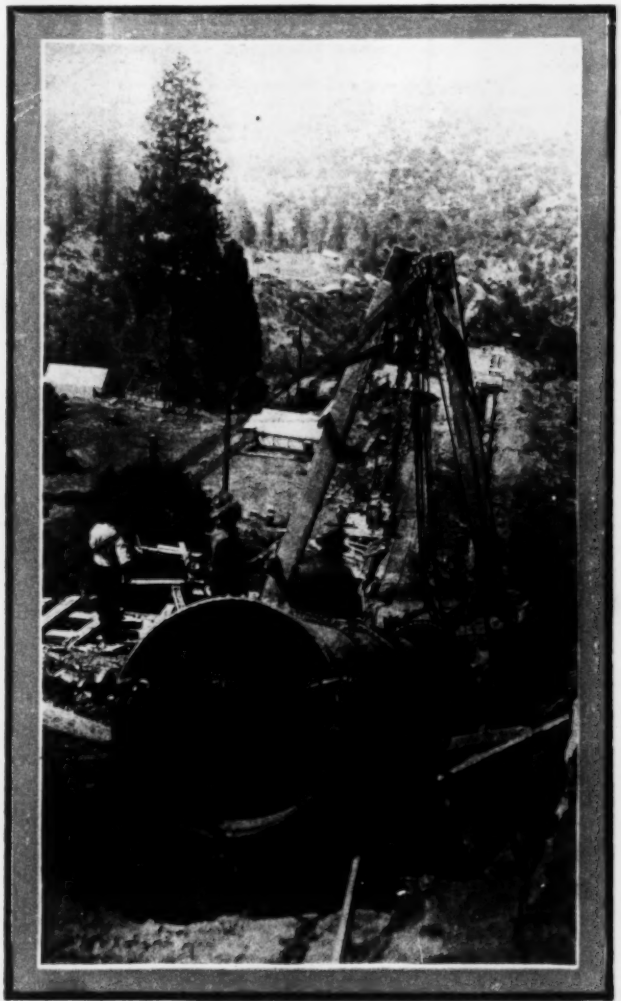

Building New Penstock for Big Creek Plant No. 2, California

In This Issue:

A New York tunneling and foundation expert, both engineer and contractor; a hydraulic engineer of the Geological Survey; the bridge engineer of the Wisconsin Highway Commission; a well-known educator, life student of public utility problems; the city engineer of Pasadena, Cal. —specialists in many fields come together in preparing the following outstanding features of this issue:

Division of Irrigation Water Between the United States and Canada
By Benjamin E. Jones

Test of Trent Activated Sludge Devices at Pasadena
By R. V. Orbison

Bituminous Surfacing for Plank Highway Bridge Floors
By M. W. Torkelson

Borrowing Power and a Fair Return for Public Utilities
By W. G. Raymond

Earth in Foundations Considered as an Elastic Solid
By Lazarus White

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
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Engineers in Port Planning

IN SPITE OF such attempts to relegate the engineer to a position as day laborer under the "practical" shipping man, as that recently made by Director Sproule, of Philadelphia's Department of Docks, the place of the engineer in harbor-terminal planning is firmly established by results in ports where he is the directing mind. Elsewhere in this issue is published a discussion, by an engineer, on the type of harbor planning that will be necessary to maintain supremacy in world trade. Here Colonel Wilgus ably demonstrates the vital importance of engineering considerations, as opposed to political and "practical" shipping considerations. Following Colonel Wilgus' paper appears the "policy" of the Port Development Commission of Baltimore, of which an engineer is chairman. At the port of New York policies are not now guided by engineers but by politicians and "practical" shipping men, with results that have made local port conditions the subject of national criticism. The policy of the Baltimore commission is so broad and clear that we publish it in full. Incidentally it emphasizes the dominance of the engineer in port planning.

Rental Charges for Equipment

DISPUTE invariably arises between engineers and contractors whenever there is occasion to determine rental charges for construction equipment. The engineer prone to regard averages as representing the facts, the contractor knowing that an average may represent a profit under one condition and a loss under another condition and neither being in possession of authoritative records of either extremes or averages, there is naturally a broad field for battle. Particular value, therefore, lies in the schedule of rental charges published on page 1288, which has been worked out after almost two years' study by the Associated General Contractors of America. There are few records of construction data which have been subjected to a more general and at the same time a more detailed scrutiny, item by item, than has this schedule which is now made public. It is therefore, definitive, as far as such lists of figures may be. There can never be, however, a final set of averages nor a set of averages which will apply under all conditions. These are facts which engineers and contractors must always keep in mind and be prepared to modify the schedule values as sound judgment, taking into consideration the attending circumstances, may dictate.

Protecting Roads in Spring

NOT so long ago highway officials felt that they were helpless to keep heavy traffic off the highways during the spring break-up. Their ideas, however, have changed radically within two years. What was regarded an impossibility in 1917 is established practice in some states now, while universally there is insistence that powers be given the state highway departments and to county officials to keep heavily loaded vehicles off the less-well surfaced highways during the period when the frost is coming out of the ground. The matter needs fresh and urgent consideration at the present time because most of the state legislatures will be in session this winter and the powers needed by the highway officials to protect the public's investment in roads can be secured. The highway sentiment is so strong at the present time that there is no difficulty in convincing a legislature that the community's investment should not be ruthlessly destroyed during the two or three short weeks of post-winter subgrade softening. The sort of enabling legislation should be extremely broad, merely conferring on the appropriate officials power to make such regulations as in their judgment are necessary to preserve the integrity of the roads at this critical period. If there be those who oppose the legislation they should be very ruthlessly exposed. No matter how great their seeming influence, they cannot withstand a plain statement of the primary rights of the community. The public is prepared to support sound highway policy.

Study of Ethics

AS ONE of the last items of the year's news concerning professional development comes the announcement that two national societies will co-operate in the attempt to write a new code of ethics. The American Society of Civil Engineers has just appointed a committee to co-operate with a committee of the mechanical engineers in the work. We welcome the attempt as a hopeful sign of progress, not because it will produce the best code of ethics—or indeed any code whatever—but because it will increase the thought which engineers of many pursuits will devote to the ethics of their relation to public and to colleagues. It is inevitable that each one of these engineers will, by virtue of such reflection, become more keenly conscious of the special public trust with which he is charged by virtue of his profession's place in community existence. So, even without the production of a code—and only a few weeks ago we stated our belief that civil and mechanical engineers can not easily find common ground for conclusions on professional ethics—co-operative study of the subject will yield benefit to the public as well as to the profession, by quickening the professional conscience and recognition of the duty of service. Beyond this, however, it is broadly true that any movement which aims to re-formulate basic principles of just conduct is of very special value at the present time. And, as the engineer's objective attitude is most essential to the world's reconstruction, it is fitting indeed that his profession should be among the first to enter upon this work of leadership.

Engineering and a Naval Base

WITH the selection of the site for a naval base the engineer as a rule has little to do. Leaving aside some elementary precautions as to foundations, the engineer will be able generally to build such a base wherever the military authorities decide is proper from the viewpoint of policy and strategy. This is not true of the San Francisco repair and supply base, the alternative locations of which are noted in the article on another page. Here the military requirements are equally, or almost equally, satisfied in any one of three locations and the proper selection unquestionably hinges on engineering details. The brief résumé of the advantages of the respective sites were much amplified in the hearings before the congressional committee, which must make the ultimate decision, but the publicity which has been given those hearings in the West does not, in our opinion, emphasize as it should the one superior quality that Mare Island possesses. That is the utilization of the costly and complete equipment of the Navy Yard existing there. Our naval authorities assert that speed in the construction of the new base is essential, if our Pacific naval policy is to be continued, and yet the advocates of San Francisco and Alameda would virtually scrap the Mare Island yard and proceed to the duplication of the most part of its equipment which will be necessary for the new base. Some years ago the channel defects at Mare Island were urged against it. Today those criticisms have been answered. Foundation difficulties at Alameda are great; San Francisco itself is ill-advised in wanting to give over for all time a large part of its not too long shore line, which, with Boston and Brooklyn before it as examples, it should want to reserve for commercial use. Mare Island and Vallejo, with no voters to speak of, can only stand on the engineering merits of their claim for preference. It will be interesting to see how much influence they have on the congressional committee.

Safety Factors for Columns

SOME recent Bureau of Standards studies of spruce struts afford a new demonstration of the fact that well-executed breaking tests of columns plot very satisfactorily in curves of the Rankine-formula type. The same fact has been shown to hold for other brittle materials—and when column behavior is in question, wood must be classed as a brittle material, since it lacks plasticity. Tests of steel and wrought-iron columns follow the same law fairly well in the upper range of length, while in the case of short lengths, where plastic deformation enters as a factor, it is at least open to question whether the point of elastic failure is not also in conformity with a Rankine curve. If it be granted that the formula for allowable loads on columns should be adapted to the breaking-load curve (which means that columns of all lengths are to have a uniform factor of safety), the case for the Rankine-Gordon formula is much stronger than the popularity of straight-line column formulas would indicate. But any theory of a uniform factor of safety fails in the face of the practice of fixing a maximum length-ratio for columns with a view to obtaining safe and substantial construction. Moreover, safety factors are matters of engineering rather than mathematical reasoning, so that a working formula can hardly be "derived" by so simple a process. It is fair to consider, therefore, whether there is any method by which test data can be utilized directly in determining a working formula for column design. The method, it would appear, must base on a study of safety factors. Hitherto column formulas have been selected by judgment in such a way that their correlation with test results has been uncertain. But if an analysis of service conditions and hazards will lead to reasonable conclusions as to the varying degree of safety desirable for different column lengths, application of these conclusions to test data will make it practicable to devise a column formula of maximum simplicity and economy of result combined with reliability.

Hydro-Electric Leadership in California

PERHAPS it is the pioneering spirit of the forty-niners reappearing in somewhat different form with the present generation, or it may be sheer necessity for leading the way in electrical fields, but whatever the reason, certain it is that the power companies of California are showing a progressive and courageous policy in their present water-power development program. A dozen or more large projects undertaken almost simultaneously could perhaps be accounted for wholly on the basis of delayed development and increasing demand for power, but new ventures in design, as described elsewhere in this issue, indicate a high degree of technical skill and the ability to convince capital that money spent on units and systems greatly in excess in size to previous practice will be a safe and profitable investment. Some of these ventures are a 165,000 and a 220,000-volt transmission line, an 806-ft. head on a reaction turbine, 40,000 hp. from a single vertical-shaft reaction turbine and 30,000 hp. from a double-overhung impulse wheel under a 1008-ft. head.

For years California has led other states in the amount of electrical energy consumed per capita. In view of the time and money spent there to bring hydro-electric development to a high degree of efficiency, it is to be expected that valuable lessons could be learned from California's experience. For example, the present trend is toward wholesale interconnection of transmission lines to make the continuity of service more certain and to make possible the exchange of "off-peak" power with the attendant improvement in load factor. All this tends to keep the companies working together harmoniously, which, in the end, benefits the consumer.

Another excellent feature of California practice—logical but none the less worthy of emphasis—is the practice of considering at the very outset, along with preliminary surveys of sites, elevations, etc., the relation of each proposed plant to existing or possible future developments. Such practice has developed because in times past there have been difficulties with plants and systems which were laid out on the old selfish basis of the greatest income from the immediate investment and with little or no consideration for later interests. Fortunately, the lesson was learned in time to be of advantage in the extensive program now under way.

In some states it has been proposed that water-power development should be permitted only after approval by a state commission which could co-ordinate the various units in a generally advantageous scheme. California has secured just that result without special legislation, apparently because the companies have found that what profits one can profit all if harmony prevail.

What About the St. Lawrence Waterway?

ACTING under instructions from the United States and Canadian governments, the International Joint Commission is now going across the two countries holding hearings on the feasibility of the proposed St. Lawrence River waterway. In time, let it be hoped a short time, it will digest the arguments made before it and, supported by the technical facts gathered by the engineering attachés, will present a report from which engineers may draw a concerted conclusion. Meanwhile, practically all discussion is partisan, because those who talk or write about it are predisposed, either by local influences or by retainer, toward one side or the other. Nevertheless, independent engineers ought to be thinking about the project, not only as citizens because they may be called upon to pay their share toward the huge sums which it involves, but also as members of a profession to which the country looks for unprejudiced and expert advice.

Until the report is available, it would be hasty to take a definite stand on the Lakes-to-the-Sea waterway. The problems are too involved and the sums to be expended too vast for an opinion built up only on assumed bases. It is worth while, though, to set down the fundamental questions that will have to be settled before a concerted judgment can be formed.

The proposal is that the St. Lawrence River from Lake Ontario to Montreal be deepened, dammed, or canalized to such an extent that deep-water navigation—25 to 35 ft.—is made possible. This involves some means of bypassing Niagara—presumably by the new Welland ship canal—the deepening of the other lake connections, the ultimate deepening of all lake channels and harbors, and the construction of port facilities to take care of the traffic for which the whole project is designed. It involves, also, the development of enormous amounts of power in the river, although such development is in no way dependent on the navigation scheme but will only be made cheaper by certain structures common to both navigation and power projects.

The issues are fairly clear, though their solutions are not. The advocates of the waterway see the freight of the world brought to the wharves of the Great Lakes cities by through ships, so that the lake cities, and with them their rich hinterland, will take on the size and importance that world-wide commerce brings. They see, too, as a necessary part of the canalization of the river, the construction of great reservoirs from which large amounts of hydro-electric power can be generated cheaply because of the joint assumption of the cost burden by the navigation and power developments. On account of the reduced cost to the Middle Northwest of transporting its products to world centers, and the reduced cost of power to the Northeast, they see a sectional prosperity which will spread over the whole country, manifesting itself sufficiently in lowered prices to make equable the spreading of the cost burden on all the people of Canada and the United States.

For these benefits they think the whole United States and Canada should be willing to expend a sum which has not yet even been estimated. The first datum that must be established is this cost. Estimates, based merely on guesswork and not even on preliminary engineering surveys of the situation, range from two hundred to three hundred million dollars. Everyone knows that the first rough estimate for public work extending over a large area and a long time is always too low. A reference to the history of such projects will confirm this. Prices tend always to increase; scope is always enlarged and never diminished; unknown and unexpected factors invariably enter. So it is safe to say that even an expert preliminary estimate may be added to materially for an indication of the real cost. The St. Lawrence project, including the necessary deepening of many harbors and channels and the construction of terminals may well run up to two or three times the estimates now given.

Such an expenditure may be warranted by the accrued benefits, but a thorough analysis of the costs and benefits, reduced as nearly as possible to dollars, must be made available before going ahead. Consideration must be given to other mammoth plans that call for national expenditure. The Mississippi and Ohio River advocates want a lot of money for their work and in the Far West far-seeing people are beginning a strenuous campaign for funds to turn the arid and over-wet lands into food-producing country. The Columbia River Basin project alone will cost nearly $300,000,000 and it certainly is a fair question whether it would not benefit the country at large much more than the St. Lawrence waterway.

Another question on which engineers will want knowledge is the possibility of a ship being built which can operate economically on both lakes and ocean. This is a critical issue. If bulk has to be broken anywhere along the line, say at Montreal, the benefits of the waterway will be materially reduced and may not be greater than those from the New York Barge Canal. True, the total carriage from the Lakes to northern Europe will be shorter and there will be one less transfer, but once bulk is broken the advantage of a single break over a double break is probably not sufficient to warrant the large expense involved.

The probable cost and the possibility of through navigation are the two big elements that must be studied but there are several others to be considered, though they are subordinate. These include the possibility of international complications, which involves, too, the distribution of cost between the United States and Canada and the fact that this, on account of ice obstruction, is only a seven-months' waterway. Neither Canada nor the United States is a unit in demanding the improvement, so the certain charges from both sides of the line that this is a selfish national proposal may be discounted in advance, but the possibilities of dispute and trouble in so large a joint undertaking must certainly be weighed. As for the part-time use of the waterway, there is much point in the accustomed reference to Montreal's successful seven-months' port.

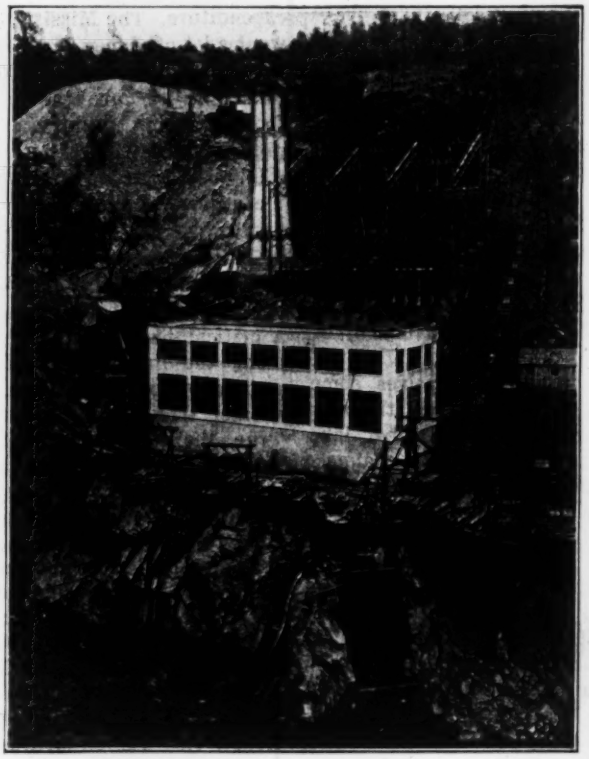
Finally, the possibility of hydro-electric development must not be overemphasized. Power is unquestionably needed in the St Lawrence district and nothing can stop its production there. The question to be decided is whether the saving made by tying in that power development to canalization is worth the extra cost the navigation improvement entails.

These are the essential elements in the St. Lawrence scheme. It is the greatest engineering problem now before the American people, for, make no mistake, the Middle Northwest is aroused in favor of it and will fight for its adoption. Engineers who look beyond their daily job should be studying its possibilities and difficulties.

Forward Steps in California Hydro-Electric Designs

Unusual Features Include 200,000-Volt Transmission Lines and Larger Units and Higher Reaction-Turbine Heads Than Have Previously Been Used

THIS is a day of great hydro-electric development on the Pacific Coast. In California, particularly, many large projects have been undertaken since the war and a group of thirteen now under way there, of which all but two are to be in service by January, 1922, will develop the large total of 522,600 hp. Numerous problems have arisen which called for pioneer work, and several new records have been established. Typical of these are the 40,000-hp. single-runner units for the Fall River plant, the 806-ft. head on reaction turbines at Kern 3 and the 220,000-volt power line that is to bring Pit River power to San Francisco. Apart from considerations wholly within the field of design, very definite progress has been made in the development policy. Preliminary studies are now made so comprehensively that ordinarily before construction work is started on any one plant the interrelation of all the others which may later be built in the same basin is analyzed in the light of the ultimate unified system. This idea, carried out between systems as well as between units, has united more than a hundred steam and hydraulic generating stations in a synchronous power network that extends the full length of California and thence well up into Nevada—a total of 1,400 miles from end to end. How thoroughly these main trunk lines are supplemented by branches and laterals is shown by the fact that the interconnected network has a total of 7,200 miles of high-tension line.



KERCKHOFF PLANT ON SAN JOAQUIN RIVER

During the war there was practically no hydro-electric development in California, but the power demand was steadily increasing. The increase averaged about 11 per cent per annum for these four years. Overlapping the latter part of the war period came three consecutive seasons of drought, which decreased the supply of hydro-electric power far below normal. Thus in a period when the industrial demand was very urgent the power shortage very effectively emphasized the need for a greater margin of hydro-electric power. This power was needed not merely because there was demand but to conserve fuel oil for such uses as were not adaptable to electric power—in ships, aircraft, etc.

After the war, and when the financial situation was finally such that construction could proceed, developments were begun simultaneously in many sections of the state. In planning these additions to the power system it was assumed, in a number of instances at least, that the power demand for the next five years might be expected to increase 12 per cent per annum. In this connection it may be noted that the total hydro-electric power that can be economically developed in the State of California is now estimated at 3,000,000 hp. Of this only about one-fifth of the better primary sites have thus far been utilized.

In developing this small percentage, however, an excellent foundation has been provided on which to carry out the more extensive plans. Seventy-five hydro-electric plants in the state are interconnected, the total power aggregating about 470,000 hp. At various points on this network the service is supplemented by forty-seven steam standby plants that can supply a total of 315,000 kw. The load on this system has been built up in such a way that the load-factor on the entire network is between 60 and 65 per cent.

An example of the pioneering policy pursued in these California developments is found in the system of the Southern Sierras Power Company, which has built a transmission line 400 miles long and delivers the major part of its 20,000-hp. load this distance.

Topographic and Climatic Conditions.—For the most part the hydro-electric power sites are in the high mountain region on the eastern edge of the state, while the centers of consumption are in the lowlands of the valleys or along the coast. Under the widely varying conditions in the northern and southern districts a variety of problems has arisen, which has naturally led to pioneering ventures. Typical of the divergent conditions is the fact that in the Pit River basin no storage is required, while in those developments in the central or southern parts of the state it is customary to provide enough storage to supply the full flow for about half the year.

Neither the Hat Creek nor the Fall River developments (Pit River Basin), which are to develop a total of 181,600 hp., are being provided with storage because of the remarkably equable stream flow they utilize. The geological formation in this entire section, some 5,000 sq.mi. in extent, is such that the precipitation on a large area passes through underground lava beds and reappears in large springs, almost perfectly regulated. The streams of this area are regarded as ideal for

PRINCIPAL CALIFORNIA HYDRO-ELECTRIC PROJECTS UNDERTAKEN SINCE THE WAR

Name of Plant	Distance via Transmission Line to Distribution Center	First Installation in Hp.	Date of Completion	Head in Feet	Type of Wheels	Ultimate Installation in Hp	Transmission Voltage	Company
Pitt River Basin: Fall River No. 1..		80,000	Aug. 1921	430	Two 40,000-hp. vert.-shaft single-runner reaction turb.; Allis-Chalmers	80,000	110,000 1st year then 220,000	Mt. Shasta Power Corp. Subsidiary of Pacific Gas & Elec. Co.
Pit River No. 1...	245 miles to center of San Francisco Bay District	80,000	July, 1922	335	Two 40,000-hp. vert. single-runner reaction turb.; contract not awarded	80,000		
Hat Creek No. 1..		9,300	Jan., 1921	215	One vert. single-runner reaction turb.; Wellman-Seaver-Morgan.	9,300		
Hat Creek No. 2..		12,300	Jan., 1921	195	One vert. single-runner reaction turb.; W.S.M.	12,300		
Caribou Plant.....	195 mi. to San Francisco (N. Fork Feather River	60,000	Feb., 1921	1,008	Two 30,000-hp. double overhung impulse wheels; Allis-Chalmers.	120,000	165,000	Great West'n Power
Moccasin Creek....	140 miles to San Francisco (on Hetch Hetchy project).....	75,000	Probably 1923	1,300	Three double-runner 25,000-hp. impulse wheels; contract not awarded	150,000	154,000	City of S. Francisco
Levining Creek.....	400 miles to Riverside.....	15,000	Oct., 1921	1,595	One single overhung impulse wheel; contract not awarded	15,000	87,000 to be raised to 140,000	So. Sierras Pwr. Co.
Spring Gap.	130 miles to San Francisco....	9,500	May, 1921	1,860	One single overhung impulse turbine; Pelton	9,500	110,000	Sierra & S.F. Power Co.
Kerckhoff Plant....	40 miles to Fresno (San Joaquin River)	45,000	Aug., 1920	335	Three 15,000-hp. vert. single-runner reaction turb.; Allis-Chalmers...	50,000	110,000	San Joaquin Lt. & Power. Co..
Big Creek No. 2A (new unit).....	240 miles to Los Angeles....	22,500	Jan., 1921	2,400	One 22,500-hp. double overhung impulse wheel; Pelton	22,500	Now	
Big Creek No. 8....	240 miles to Los Angeles.....	25,000	Jan., 1922	717	One 25,000-hp. vert. reaction turb.; I. P. Morris	120,000	150,000 to be raised to 220,000	So. Cal. Edison Co.
Kern River No. 3...	130 miles to Los Angeles. ..	45,000	Feb., 1921	806	Two single-runner vert. reaction turb., Pelton	45,000		
San Francisquito No. 2.....	50 miles to Los Angeles (on L. A. Aqueduct)	44,000	Aug., 1920	530	Two 22,000-hp. vert. reaction turb.; W.S.M	61,500	110,000	City of Los Angeles

power development and it is estimated that about 500,000 kw. could be developed upon this watershed without providing reservoir storages.

A very different condition exists south of the North Fork of the Feather River. Here there is very little ground storage, and stream flow must be supplemented by reservoirs. The snow pack in the high Sierras, which is the source of summer stream flow, is ordinarily melted off by midsummer, and the chief factor in economic power sites in this district is the question of practicable reservoir sites. Ordinarily, good practice prescribes development here for about 75 per cent of the normal stream flow, and for safety it is regarded as highly desirable to be able to supply the full flow from storage for 150 to 200 days. The question of silt does not enter into the storage problem because, with the exception of the Colorado River, none of the important California power streams regularly carry any considerable amount of silt.

Some California streams have large power possibilities. Figures on four of the rivers having important power sites are given in the following table:

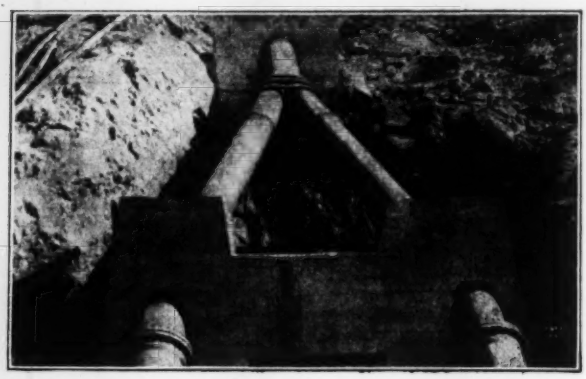
Drainage Basin	Recently developed or under construction	Proposed for development in next five years kw.	Possible economic development (estimated), kw.
Pit River	181,600	200,000	500,000
Big Creek	100,000	300,000	500,000
Feather River	100,000	200,000	300,000
Colorado River	.....	.....	200,000

The widely diversified conditions in different parts of the state have greatly increased the advantages of connecting the transmission lines. Not only have tie-ins been made at practically every feasible point but choice of location for new power plants is influenced materially by present and prospective developments and their transmission lines. The desire to deliver, in the ultimate system, the greatest amount of power for the minimum investment is tempered by the need for assuring continuity of service, and where necessary plants are built for this express purpose.

SAND TRAP AT HEADWORKS, KERN RIVER NO. 3

Characteristic of the developments now under way is the repeated use of the same water in a series of power houses. The plants are built in whatever order fits in best with existing power demand and financial conditions, but the relation of each plant to the others is carefully studied before any program is adopted. In fact, not only are the relations of all possible sites on a basin studied comparatively but the bringing in of additional water from other drainage basins is also considered. On the Big Creek system a 10-mile tunnel is being driven to bring the waters of the San Joaquin River into Huntington Lake, thus diverting a large steady flow into the upper end of a series of eight plants, several of which have already been built, in which a total fall of 5,950 ft. is utilized.

Design of Hydraulic Units.—The development of water power on this extensive scale has brought about changes and progress in the design of hydraulic units. As longer transmission lines have come into vogue and the amount of power developed on a single system has increased there has come a demand for larger generating units. In fact, the size of the units is now consid-



PENSTOCK FOR NEW UNIT, BIG CREEK NO. 2

ered as having a direct relation to the size of the system. It is considered desirable to have each important generator large enough to provide charging current for the entire transmission line which it serves, so as to avoid danger of current surges back through the generator. Units of smaller size are believed to be less efficient in voltage regulation, or might even be burned out by surges. Thus electrical reasons have really brought about the steady increase in the size of hydraulic units. Though the trend has been in this direction for some time a step that exceeds all previous records is being made in the Kern 3 plant (which is to go into service next February) by using reaction turbines under an 806-ft. head. This plant will be watched with keen interest, because it is expected to have a decided effect on the design of hydraulic turbines.

In the light of recent experience reaction turbines of the future, manufacturers affirm, will certainly be built not only for still larger power outputs but also for even higher heads than that at Kern 3. Thus the reaction turbine is entering a field which heretofore has been considered the exclusive province of the impulse type. With moderately high heads, the use of reaction turbines of larger capacity and higher speeds will tend to keep down machinery costs and secure a higher operating efficiency. The costs of reaction and impulse types (particularly when their settings are considered) vary with conditions too much to permit of comparing figures, but a fairly definite comparison may be made on the basis of efficiencies. The reaction turbines ordinarily show, according to manufacturers' records, an efficiency of about 90 per cent as compared to about 86 per cent for impulse wheels.

In the Kern 3 plant the 22,500 hp. on the single runner is more than could be put (in the present stage of the art) on any impulse unit operating at the same speed. Hence the general opinion that this plant marks a step, the success of which will open up great possibilities in the attainment of more ideal hydro-electric development.

Advance is also being made in the design of impulse wheels. Although the reaction type has been making more rapid progress of late there is reason to believe, the manufacturers point out, that these advances will be very closely followed by progress in impulse wheel design, which will adapt waterwheels of this type to service not before attempted.

Summarizing the tendencies that stand out prominently in the very active hydro-electric field in California they are (1) a readiness to make comprehensive, relative studies of all the power sites, regardless of ownership, that can be economically developed on an entire stream or basin, with a view ultimately to connecting them electrically; (2) a steady increase in the maximum heads considered feasible for reaction turbines; and (3) a rapid increase in the size of hydraulic units it is considered practicable to build.

Table of Corrections to Obtain Back Azimuths

By S. W. Tay
Sanitary Engineer, Honolulu, T. H.

THE following table of corrections to obtain the back azimuth of a line was prepared with the view of assisting the surveyor while in the field in the Hawaiian Islands. A similar table can easily be compiled for the general locality where survey work is to be carried on and where the azimuth method is used. The method by which the table is used is as follows:

Given: Azimuth, and distance from point *A* to point *B* and the approximate latitude.

To find: *Dz*, or back azimuth.

Let the forward azmuth of the line *AB* = 200° 20′; the distance *A* to *B* 24,000 ft., and latitude 19° 10′. Then, the departure sin 20° 20′ × 24,000 = .3475 × 24,000 = 8,340. Interpolating in table with departure 8,340 and latitude 19° 10′ we obtain a correction of 29 seconds to be added to the forward or original azimuth, which result added to 180° 00′ gives the true back azimuth equal to 20° 20′ 29.″

TABLE OF CORRECTIONS TO OBTAIN BACK AZIMUTH
For Easterly Departure, Add Dz
For Westerly Departure, Subtract Dz

Departure, Feet	Correction in Seconds for Latitude 19° to 22°						
	19° 00′	19° 30′	20° 00′	20° 30′	21° 00′	21° 30′	22° 00′
1,000	3.39	3.49	3.59	3.68	3.78	3.88	3.98
2	6.79	6.98	7.17	7.36	7.56	7.76	7.96
3	10.18	10.47	10.76	11.04	11.34	11.64	11.94
4	13.57	13.96	14.34	14.72	15.12	15.52	15.92
5,000	16.97	17.45	17.93	18.41	18.90	19.40	19.90
6	20.36	20.93	21.52	22.09	22.68	23.28	23.88
7	23.75	24.42	25.10	25.77	26.46	27.16	27.86
8	27.14	27.91	28.69	29.45	30.24	31.04	31.84
9	30.54	31.40	32.27	33.13	34.02	34.92	35.82
10,000	33.93	34.89	35.86	36.81	37.80	38.80	39.80
11	37.32	38.38	39.45	40.49	41.58	42.68	43.78
12	40.72	41.87	43.03	44.17	45.36	46.56	47.76
13	44.11	45.36	46.62	47.85	49.14	50.44	51.74
14	47.50	48.85	50.20	51.53	52.92	54.33	55.72
15,000	50.90	52.34	53.79	55.22	56.70	58.20	59.70
16	54.29	55.82	57.38	58.90	60.48	62.08	63.68
17	57.68	59.31	60.96	62.58	64.26	65.96	67.66
18	61.07	62.80	64.55	66.26	68.04	69.84	71.64
19	64.47	66.29	68.13	69.94	71.82	73.72	75.62
20,000	67.86	69.78	71.72	73.62	75.60	77.60	79.60
21	71.25	73.27	75.31	77.30	79.38	81.48	83.58
22	74.65	76.76	78.89	80.98	83.16	85.36	87.56
23	78.04	80.25	82.48	84.66	86.94	89.24	91.54
24	81.43	83.74	86.06	88.34	90.72	93.12	95.52
25,000	84.83	87.23	89.65	92.03	94.50	97.00	99.50
26	88.22	90.71	93.24	95.71	98.28	100.88	103.48
27	91.61	94.20	96.82	99.39	102.06	104.76	107.46
28	95.00	97.69	100.41	103.07	105.84	108.64	111.44
29	98.40	101.18	103.99	106.75	109.62	112.52	115.42
30,000	101.79	104.67	107.58	110.43	113.40	116.40	119.40

Primary-Road Maintenance by the State Asked in Washington

In his biennial report, James Allen, highway commissioner of the State of Washington, asks that maintenance of all primary highways be placed under the direct supervision of the state highway department, and that a sufficient appropriation be made for such maintenance. The commissioner also recommends that counties initiating work upon state highways first submit plans to the commission for approval. Re-appropriation of $1,000,000 as a revolving fund from which to make advance Federal-aid payments, is also asked.

Observations on a Pacific Coast Trip

By Frank C. Wight
Associate Editor, *Engineering News-Record*

Portland

EVERY morning now the Portland newspaper carries a black-face box on its first page showing the previous day's bank clearings for Seattle and for Portland. Every day Portland is a million or so ahead of its northerly and larger rival. When, or if, the balance turns, interest in the figures may not be so great but for the present they express very well Portland's hope that the race is not always to the swift. For Portland has never been a boom town. It was founded many years ago at the confluence of the rich Willamette and Columbia valleys and, regardless of gold strikes or wars, has built itself upon the sure sources of wealth in its prolific hinterland and the excellent, though constricted, passageway to the sea. Age and sure growth make for a conservatism which is reflected in its people and its buildings and which in these days of general slackness comforts itself with the knowledge that reaction and action are apt to be equal or, to translate into less polite terms, "the bigger they come, the harder they fall."

Oregon's great industries are lumbering and farming. The current depression is reflected in the former but agriculture is not a fluctuating trade. The Columbia River basin and the stock country to the south continue to contribute to the world's necessary supply of food. Because of these conditions engineers in Portland—outside of those working strictly in city work—are largely interested in irrigation and drainage. All over the state are located districts which never figure in any but local news, where the engineering details of design, construction and maintenance require expert and constant attention.

Mainly as a result of this sort of practice, there is heard here with extra emphasis the complaints of the northerly cities against government usurpation of the private engineer's function. This complaint is not only against the Reclamation Service and the Bureau of Public Roads but also—and perhaps mostly—against the drainage investigation service of the Agricultural Department, which is also under the Bureau of Public Roads.

The criticism of these three governmental activities is different for each. It is common talk throughout the Northwest that the Reclamation Service discourages irrigation by the superfineness of its work. There is such a thing as being too careful and of building too strongly, of insuring too much against the future. This habit of the Government is natural, for it is a perpetual institution and its bureaus must be prepared for all contingencies; but some of the engineers who are trying to develop small areas are hampered, they think, by the, to them, unnecessarily high standards the Government sets. They feel, too, that the money could be spent to better advantage to the community if spread over more work.

Comment was made in my Spokane letter regarding the too great centralization of the Federal road aid and this criticism is also found in Oregon, though not so generally expressed. The main trouble here seems to be with the drainage investigators who, according to several independent observers, are going hither and yon throughout the country making reports—none too accurate or careful—on possible developments and are thereby depriving those in private practice of their principal means of support as engineers. These reports are not on Government work but are rendered free to any who ask. The average farmer apparently believes that the adage that "what you get for nothing isn't much" does not apply to free Government engineering.

Society Activity

Engineering society conditions are complicated in Portland. In fact, the national situation is duplicated on a minor scale. There is a large, active and very strong Oregon Chapter of the A. A. E., functioning particularly in discussion of public questions; there is a cohesive section of the Am. Soc. C. E., somewhat in opposition to the A. A. E., but with many members in common, and there is the prototype of Engineering Council in the Oregon Technical Council, composed of representatives of the national, civil, electrical and mechanical engineering societies, the American Institute of Architects and the National Electric Light Association. Just as in the national situation, it is difficult to get unbiased opinion on how the thing will work out but unless they come to open warfare it does seem as though Oregon's engineers ought to be brought sufficiently before the public eye.

In two or three recent state issues the engineers took decided stands and received columns of newspaper publicity. The extent to which their campaigns were carried and the material success they achieved makes one wonder whether such campaigns may not be dangerous. There is a widely held theory that on any given question that concerns them, engineers will hold the right view. This presupposes, first, that there is always an absolute right and an absolute wrong and, second, that engineers will unanimously support the right. The first assumption is ridiculous and, although we may not care to say so except among ourselves, the second is equally so. However, that theory is the basis for public campaigns and the result may well be that a misinformed or misguided small majority, in control of an engineering society, will propagate in the name of the profession views to which a substantial and perhaps more expert minority dissent. According to some guarded remarks, such a condition has existed in Oregon, but the issue was not of sufficient importance to call for public remonstrance. The possibilities of danger are sufficient to make the enthusiasts for public service careful.

Engineering Work in City

In the city itself engineering work is quite active or at least prospects of work are good. The Columbia Slough sewage diversion, whereby a channel is being cut between the river and an adjoining slough to facilitate sewage movement and to reclaim land, is under way and preparations are being made for the construction of a two-million dollar bridge at Burnside Street across the Willamette. The city is on both sides of this navigable and sizable stream and more bridges will undoubtedly be required in the next few years. Then, too, steps are being taken to reclaim much of the river district and to reconstruct the old wharves in the central part of the city as well as

to improve street conditions near the wharves. By misunderstanding probably, the rest of the state overruled Portland's vote at the recent election to unify the port control, which is now divided between a State port authority, a city dock commission and the city government itself. The same initative bill included an ambitious scheme to reclaim for industrial purposes a large overflow area near Swan Island, in the Willamette, and to build a new dock area and dredge a new channel. The proposition will now go to the legislature and has a fair chance of going through.

The new No. 4 Terminal, formerly called St. John's Terminal, where is located the grain elevator which caused some worry by its subsidence about a year ago, is an admirable piece of work, quite the most modern and efficient river terminal—for ocean going vessels—on the continent. Here again in a minor port one sees the latest and best ideas of port development worked out in a successful manner. The grain elevator is now complete and, thanks to the extra outside piling, seems to be stable.

As I went through the station on my way to take the train for San Francisco I ran into one of the engineers with whom I had lunched at a group meeting that day. He was in mackinaw, riding breeches and boots, en route up-country to some project or other. I thought his dress a fair example of the difference in engineering conditions in the big cities of the West and of the East. Out here they are close to the big outdoors. The wilds and the natural problems in the rough are part of their daily work and yet not all of that work. They have the comparative physical ease and creature comfort of the city office, with its association with other men and other trades, which the engineer entirely in the field lacks and which he needs for a full rounding of his knowledge and his attitude toward things. At the same time as a part of their regular task they do get out into the country where their theories are practiced.

A month ago I ran into a prominent New York engineer on Fifth Avenue in muddied clothes and flannel shirt and he apologized for them. In these Northwest cities such an apology is neither expected nor given. Every one of these cities is framed in mountains. From the streets of any of them one can look up into the hills, stretching on into the back country where the engineer does his work. There is something to look at besides the bricks and stone of the plains cities or the eastern seaboard.

Can one wonder that men living here take on some of the qualities of the open spaces?

Notes on Iowa Sand Filters for Sewage

In the discussion of the operation of Iowa sewage sand filters at the recent conference of operators at Iowa State College, C. H. Currie advised a 3-in. dose on a 2-ft. bed, which is the minimum depth in Iowa practice. Lafayette Higgins advised dividing the beds into units by sand ridges and making a gutter along the edge of the beds to retain surface wash. For winter operation he urged scraping into piles 8 to 10 ft. apart rather than the furrow or ridging method. With settled sewage a loading of 2,000 people per acre could then be obtained with 50 to 100 gal. per capita flow. In many Iowa cities the ground water is close to 50 gal. per capita.

Considerations in Design of Heavy-Traffic Pavements

BY PREVOST HUBBARD
Chemical Engineer, The Asphalt Association, New York

[*Paper presented before the Engineers' Club of Philadelphia, Dec. 21, 1920.*]

THE load-carrying capacity of any type or design of pavement must of necessity be influenced by the support afforded the pavement from below. Such support is furnished by that portion of the earth directly below the pavement, known as the subgrade. The supporting value of natural subgrades varies enormously, as illustrated by the two extremes of muck or quicksand and solid rock. Most subgrades consist of soil lying between the extremes mentioned but still varying greatly in supporting value depending not only upon type but upon their moisture content and degree of compaction. With very few exceptions any well-compacted soil will of itself support the heaviest conceivable traffic if its moisture content is properly controlled and if it is protected by a structure which prevents the displacement of particles at its surface. The protective structure termed the pavement will then need to be only of sufficient thickness to afford such protection and

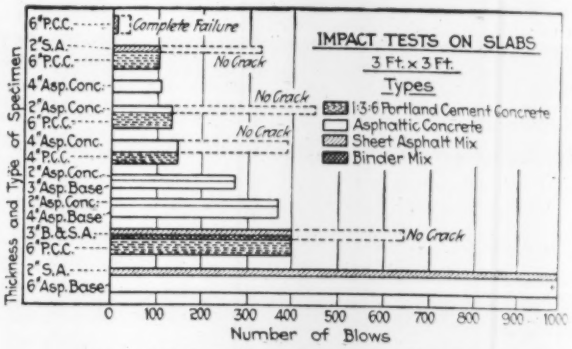


FIG. 1. IMPACT TEST RESULTS FOR SLABS

at the same time itself withstand the various destructive agencies of traffic. For a given traffic this thickness will depend largely upon the type of pavement used.

The bearing capacity of most soils, particularly the clayey types, decreases as their moisture content increases above a certain point. Although there is much yet to be learned regarding the comparative bearing value of soils this fact is generally recognized and various drainage methods are employed to control the moisture content of the subgrade. Proper drainage is the first essential for maintaining a dry subgrade and measures taken to prevent access of water to the subgrade directly below the pavement are often more important than measures designed to remove accumulations of water in the subgrade. Some soils are so persistently retentive of moisture once absorbed that it is impossible to remove it with sufficient rapidity by any ordinary system of drains. Certain clayey soils belong to this class and when all practical preventive measures in the way of drainage are apt to prove inadequate it may well be advisable to modify the character of the subgrade material. Thus at relatively low cost a clay subgrade may often be greatly improved by mixing it with sand in exactly the same manner as in the construction of a sandy-clay road. Such a mixture will not only retain less moisture than the clay but will possess a much higher supporting value than moist clay.

It is now generally admitted that in the past too little attention has been paid to drainage in the construction of pavements outside of municipalities. At the same time there exists a marked tendency to increase the massiveness of design to a point far beyond that which is at present proving entirely satisfactory for heavy traffic in municipalities and in other places where subgrade conditions are favorable. This matter should receive the most careful

consideration of engineers as it points not only to the most logical but also to the most economical solution of the design of pavements. It is evident that in many cases it will cost far more to increase the thickness of a pavement to such an extent that it will distribute the load sufficiently to enable a poor subgrade to support it than it would be to change natural subgrade conditions so as to create a high supporting value for the relatively thin pavement.

The widespread use of rigid pavements or pavements with rigid foundations has been largely responsible for this trend in paving design through too great dependence upon the bridging value of such rigid types, and right here there exists a rather anomalous situation, for while many claims are made of the bridging value of rigid pavements it is generally admitted that careful preparation of the subgrade is necessary to uniformly support these rigid types. As a matter of fact it is impracticable to design a highway which will permanently bridge appreciable areas of a weak subgrade when subjected to modern heavy traffic.

In pursuing a policy upon which general attention has once been centered many who are interested in highway construction are apt to overlook the experience of others following different lines of development and fail to profit by their experience. One of the most striking examples of this has to do with the flexible type of construction as represented by the asphalt base pavement, and this in spite of a number of valuable papers and discussions upon the subject by leading engineers. Citations of past and present experience in localities other than that of interest to the individual engineer apparently carry little weight once the majority concentrate on a given line of development, and it is difficult to focus attention on any other line for the time being.

To state that considerably over 12,000,000 sq.yd. of asphalt base pavement are now giving satisfactory service in California and Oregon, many of them 5 in. or less in total thickness and subjected to heavy motor truck traffic, and that some of these pavements have been in service for over 20 years with little or no cost for maintenance, should at least arouse some degree of interest on the part of Eastern engineers. To further state that in such cities as Washington, D. C., Chicago, Omaha, Pittsburg, Buffalo and Denver there are in existence sections of bituminous base which have given satisfactory service for over 20 years should also serve to dispel any illusion that the serviceability of this type is restricted to any given locality.

Service results should in themselves be conclusive, but explanations of such results are sometimes required before their full significance is grasped. It is true that theories have been advanced, but these have not been backed up by test data in such a way as to make them convincing. Some degree of cushioning effect under traffic has been claimed and admitted for the asphalt base as well as the wearing course, but few engineers have believed that a mineral aggregate cemented together with asphalt could possibly possess any degree of slab strength or beam strength, at least to an extent comparable with the rigid type of construction.

Impact Studies Begun

With this in mind an investigation was begun under the direction of the writer assisted by W. E. Rosengarten, traffic engineer of the Asphalt Association, to determine certain relations that exist between the rigid and flexible types of construction. Fortunately through the very valuable work of the U. S. Bureau of Public Roads it has already been proved that impact, and not dead load, is the most destructive traffic factor to be taken into account in the design of modern highways. It was therefore decided to limit these investigations to a study of the effect of impact upon test specimens having thicknesses equivalent to those commonly used in the construction of highways. It was clearly realized in advance that it would be impossible to duplicate all of the variable conditions under which impact is delivered to a pavement by traffic, and it was therefore decided to confine this study to the effect of pure impact as delivered by an iron ball falling from a relatively small height.

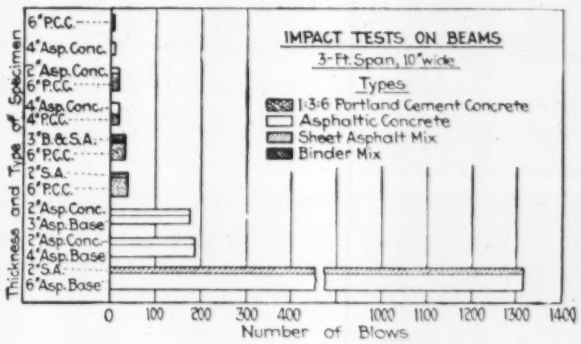


FIG. 2. IMPACT TEST RESULTS FOR BEAMS

The following description of tests will be brief, both because of the limited time available for the presentation of this paper and because the results here reported are only a portion of those included in a more comprehensive investigation involving other comparisons which will shortly be presented in a detailed article.

In order to obtain comparisons at two extremes of conditions it was decided to construct and test slabs of various design upon a solid uniform subgrade and to test beams of the same design supported only by knife edges. A plot of ground was secured and upon this was laid a 6-in. course of cinders thoroughly compacted by rolling. Slabs 3 ft. square were constructed directly upon this subgrade except that after the forms had been placed the subgrade within the forms was leveled up with a very thin layer of sand so that each specimen would have a uniform thickness throughout. Portland cement concrete slabs of a 1:3:6 mix were cast 4 and 6 in. thick. These were cured under a cover of moist sand after they had set. Some of the concrete slabs were then covered with from 2 to 4 in. of coarse, graded aggregate, asphaltic concrete and some with sheet asphalt with and without a binder course. In addition, slabs were constructed of asphaltic concrete base mixture and covered with either asphaltic concrete surface mixture or with sheet asphalt so as to produce total thicknesses directly comparable with the Portland cement concrete base specimens. At the same time corresponding sets of beams 4 ft. long and 10 in. wide were constructed of the same type and thickness. In general, the specimens were tested when the concrete was 28 days old, although in a few cases they were slightly older when, for one reason or another, it was found impossible to keep up with the testing schedule which had been planned.

How Tests Were Made

All slabs were tested where they had been cast by means of a machine which was designed and operated so as to drop a 125-lb. iron ball upon the center of the upper surface from a height of 6 in. at the rate of about 30 blows per minute. In all cases a specimen was considered to have failed when the first crack appeared. Cracks in the Portland cement concrete were invariably first noted developing on one or more sides of the specimen from the plane of contact with the subgrade. Under continued impact these cracks traveled to the upper surface of the monolith and then across the upper surface toward the center. The all-Portland cement concrete specimens broke into two to four large fragments shortly after the first cracks appeared, while similar slabs with an asphalt top showed no cracking of the top after the base had failed. The results obtained on check specimens were in some cases erratic and in others quite close together. By averaging results, however, the general trend is apparent and is closely borne out by results obtained on the beam specimens.

The accompanying diagram, Fig. 1, shows the resistances to impact of the various types of slabs as measured by the number of blows required to produce failures. The dotted extensions of the asphalt tops on slabs with a Portland cement concrete base show the number of blows at which the test was stopped, no failure of the top then being apparent.

The beams were tested upon steel knife edges 3 ft. apart with the same machine used for testing the slabs, but with a 50-lb. iron ball dropped from a height of 1½ in. at the center of the span at the rate of about 50 blows per minute. The number of blows required to produce the first crack was recorded as point of failure. In all beam tests complete failure occurred within a very few blows after a crack appeared. The results of these tests are shown in Fig. 2 in the same manner as the slab tests.

What Diagrams Show

In considering these diagrams no attempt will be made to draw conclusions based upon a comparison of absolute values as here shown. In fact, it is frankly admitted that such a course would be unwise until much more test data is available. It is believed, however, that the general similarity in trend of the results obtained in both the slab and beam tests is highly significant and points to interesting facts. What is clearly apparent for conditions under which these specimens were tested may be summed up as follows:

Asphaltic mixtures develop very decided slab and beam strength, as measured by their resistance to impact. The all-asphalt type of a slab and beam appears to offer considerably more resistance to impact than an equivalent thickness of 1:3:6 Portland cement concrete, considered either as an integral structure or as a base for an asphaltic top.

It is recognized that, unsupported by practical service results, deductions drawn from these tests might not be conclusive as applied to the design of highways for heavy traffic. They do, however, help to explain the remarkably satisfactory service record of the millions of square yards of 4 and 5-in. asphaltic concrete pavements in California and Oregon and point the way to a more rational development in the design of highways in other localities. In summing up the substance of this paper there are a few points which the writer wishes to emphasize:

Conclusions

1. Any rational design of highway should take into account the fact that the subgrade must ultimately take the weight and shock of traffic as transmitted through the pavement and practically any reasonably dry subgrade will do this if it is compacted and its surface is protected from displacement. Careful attention to subgrade preparation and drainage is, therefore, the first essential to be considered.

2. The asphaltic concrete pavement is highly resistant to impact which is recognized as the most destructive traffic factor and under impact develops as a single unit relatively high slab and beam strength.

3. It is manifestly uneconomical, if not impracticable, to adopt a design of highway which will permanently bridge appreciable areas of weak subgrade. While the asphalt type develops bridging action to an appreciable extent it will of itself constantly seek to maintain contact with the subgrade at all points and thus reinforce itself with the maximum supporting value of the subgrade. The rigid type of pavement or base cannot do this because of its inherent characteristics. It is, therefore, almost sure to crack eventually where appreciable areas of subgrade fail to support it uniformly.

4. Both the service history of asphalt base pavements and the test data here presented indicate that under given conditions it is not necessary to adopt as massive a design for the flexible type of base as for the rigid type. It is difficult for engineers who have had no opportunity to observe the asphalt base pavement under heavy traffic to think of it in terms of less thickness than the rigid base but in the light of present experience such consideration appears to be entirely warranted.

[Photographs furnished by Mr. Hubbard, but which would not reproduce well, indicate little if any deflection or deformation of the slabs that would have rendered them unsuitable for pavement base before cracking occurred.—Editor.]

Fees and Services of Practicing and Consulting Engineers

Extracts From Report by W. L. Benham, Chairman of A. A. E. Committee, Giving Minimum Schedules and Defining Services

FROM the report of the committee on fees and services of practicing engineers of the American Association of Engineers (W. L. Benham, chairman) made public last week, the following extracts are taken:

Is it not high time for practicing engineers to establish a definite basis of fees and charges for engineering services? Adequate engineering fees is a subject much talked about but very little practiced. Many elaborate schedules have been prepared by the various engineering societies and organizations of this country but it may be stated without fear of successful contradiction that very little has been accomplished to bring about practical results for the engineer. The public has not been educated to a point where it knows what reasonable charges are or really understands the scope of services which engineers are expected to render. The engineers themselves have stood in their own light and this may be the reason why the public holds its present attitude towards them. In order to obtain successful results engineers must make up their minds to pull together with a clearer understanding of their rights as well as their responsibilities and duties. A more strict adherence to the numerous codes of ethics of our engineering societies will go a long way toward bringing about a spirit of co-operation among engineers and helping us to accomplish our ends. We cannot force the public to recognize us; we do not advocate the accomplishment of our ends through the medium of strikes. Recognition must be achieved by education of the public, co-operation among ourselves and service to our clients.

Realizing the need of efforts in behalf of the practicing engineer, and by this is meant the engineer who sells or contracts his services and that of his organization, the national executive committee of the American Association of Engineers appointed a committee of practicing and consulting engineers to consider the scope and practice of engineering activities, the desirability of having uniform practice with reference to fees and scope of services, and the feasibility of establishing such practice.

The consensus of opinion of members of the committee seems to be that it is not possible to establish any hard and fast uniform or standard schedule of fees for practicing and consulting engineers for all classes of work and for all contingencies, but it is believed that some definite schedule can be adopted as a basis for *minimum* charges.

It seems to be the desire of the majority of the committee to draw a line of demarcation between the practicing and consulting engineers and to allow the latter sufficient latitude so as to enable them to obtain higher fees.

A *practicing engineer* may be termed one who is actively engaged in the practice of engineering, such as the making of surveys, designs, plans, specifications, valuations, appraisals and reports and supervising work of construction, and who contracts with his clients for engineering services, as differentiated from the engineer who is employed on a salary basis.

A *consulting engineer* may be termed one who has had highly specialized training and experience in certain lines of engineering and who has mature judgment and experience in general engineering—experience which qualifies him to act in the capacity of adviser to other engineers or directly to their clients, to design and supervise the construction of the more important engineering problems—as apart from the practicing engineer who is engaged in the design and supervision of the more simple projects.

As a general guide for the establishment of fees for professional services of engineers, for work in the United States within the field of the engineer, the following is suggested. These services can be divided into two classes, as follows:

TABLE OF PERCENTAGE FEES FOR ENGINEERING SERVICES

Service Classification	Estimated Cost of Project										
	$10,000 to $25,000	$25,000 to $50,000	$50,000 to $100,000	$100,000 to $200,000	$200,000 to $300,000	$300,000 to $500,000	$500,000 to $750,000	$750,000 to $1,000,000	$1,000,000 to $1,500,000	$1,500,000 to $2,000,000	$2,000,000 and up
B-1 Surveys	Actual Cost Plus 25% and Upward										
B-2 Preliminary reports	2 25	1 75	1 20	80	70	60	55	50	45	40	40
B-3 Plans and specifications	5 00	4 50	3 75	3 25	3 00	2 75	2 65	2 60	2 55	2 50	2 50
B-4 General supervision	2 00	1 90	1 70	1 50	1 40	1 35	1 35	1 25	1 20	1 15	1 10
B-5 Resident Supervision	Actual Cost Plus 25% and Upward										
B-6 Purchasing	2 00	1 80	1 35	1 00	90	85	80	75	70	70	65
B-7 Management	5 50	5 00	4 30	3 50	3 00	2 75	2 55	2 45	2 35	2.25	2.15

A. Special Engineering Service

1. Consultation. 2. Arbitration. 3. Professional advice. 4. Expert testimony and court work. 5. Valuations and appraisals. 6. Service and efficiency tests. 7. Reports.

B. Regular Engineering Service (See table)

1. Reconnaissances, surveys of all kinds, borings, soundings, tests, experimental work and compilation of all data necessary for preparation of preliminary report, estimates of cost and for plans and specifications.

2. Necessary conferences, preparation of preliminary plans, estimates and report covering all features of the work with various alternate plans setting forth advantages and disadvantages, cost of operation and maintenance and recommendations for solution of the particular problem.

3. Preparation and presentation of working plans, profiles, specifications and estimates for letting of contracts or purchase of material and machinery and for complete information of client or owner, describing in detail manner under which contract or contracts will be let, general stipulations, complete detailed description of all parts of the work, general manner in which work shall be done, forms of proposal blanks, contracts and bonds, and detailed estimates of cost.

4. Attendance and advice at meetings for award of contracts of construction or for purchase of materials and machinery, supervision of construction work during progress, progress reports and rendering of estimates. By "general supervision" is meant occasional visits of a principal to the work, and such office work at headquarters which is necessary to prepare progress estimates and reports, correspondence between field and office and final records. It does not include surveys and inspection work in the field or testing.

5. Resident supervision of construction continuously "on the ground" during the progress to see that the plans and specifications and contract are being complied with.

6. Purchase of all materials, equipment and machinery.

7. Complete management of project from conception to completion, but not financing.

Charges for all classes of work under "A" may be placed on the per diem basis. The amount of the charge should vary according to the character, magnitude or importance of the work or subject involved or according to the experience and reputation of the engineers. This charge should vary from $50 a day upward and it may be considered legitimate to charge a retainer fee of $250 or more. An additional charge should be made for all actual expenses, such as traveling and general office expense, field assistants and materials used, with a suitable allowance for indeterminate items, plus a profit on this portion of the work of at least 25 per cent over and above all expenses as above enumerated. In such cases when doing office work 8 hours shall be considered to be a day, but when absent from the city each day of 24 hours while away from the office shall be considered a day, regardless of the actual time spent on the work. This includes all days in travel going to and from location of engagement. Payment for services shall be made monthly as the work progresses or upon submission of report or upon completion of work as outlined in contract.

In lieu of the per diem charge a fixed total sum for services may be agreed upon. In determining this fee, however, the per diem charges plus expenses should be figured as closely as possible, with a reasonable allowance for contingencies. It may be considered legitimate to charge a retainer fee. Payment for services shall be made monthly as the work progresses or upon submission of report or upon the completion of the work as outlined in the contract.

Charges for work as set out under "B" may be made on a percentage basis according to the table.

The percentages in the above table are to be computed upon the entire cost of the completed work exclusive of legal and engineering, or upon estimated cost pending execution or completion.

The term "cost of work," as used, refers only to such part or parts of the whole work or project as the engineers may be engaged to deal with in any of its stages.

Payment for services shall be monthly.

General Provisions

1. Upon undertaking engagement a written contract should be entered into stating as fully and clearly as practicable the conditions of the engagement, services to be rendered and amount or rate of compensation.

2. When alterations or additions are made to contracts, drawings or specifications, or when services are required in connection with negotiations, legal proceedings, failure of contractors, franchises or rights-of-way, a charge based upon time in office and field and all overhead expense should be made in addition to the percentage fee agreed upon as in case of B-1 and B-5 of the table.

3. In case of abandonment or suspension of the work at any time an adjustment of the fee shall be made on the same basis as that of the partial payments or by application of the per diem rates for all work done previous to notification of abandonment. Engineers should keep their records so that such cost may be accurately determined.

4. When services are required other than those reasonably to be expected for proper fulfillment of the contract per diem charges may be made, if the work involved be of sufficient magnitude, in addition to percentage fees provided for.

5. Engineers may with propriety undertake all the work in connection with the project, including business, legal and other matters, in which case the fee shall be the subject of special agreement.

6. It should be recognized that in any project undertaken by an engineer there may be many problems requiring the services of a specialist. Testing and inspection of materials at factory or plant shall be construed as coming within this class. The cost of such specialist shall be paid by the client or owner.

7. Drawings and specifications by any method of payment for services are to be considered the property of the engineer but the client is entitled to receive a reasonable number of complete records of the same. All other copies shall be paid for by the client on basis of actual cost.

8. It is for the best interests of the client or owner that the engineer be given full direction of the work during the construction period, or, if this is impracticable, that the client employ experienced inspectors approved by the engineer and working under his general supervision.

New York City's Immense Budget

The budget of New York City for 1921, adopted on Dec. 6 by the Board of Aldermen just as framed by the Board of Estimate and Apportionment, totals about $346,000,000, besides which there is an estimated deficit in the education appropriation of some $25,000,000 for which provision must yet be made. The 1920 budget, not including the deficit, is about $72,000,000 above that for 1919 and is expected to call for a tax rate of from 2.75 to 2.85.

Earth in Foundations Considered as an Elastic Solid

Deductions from Angle of Repose Theory Disputed—Earth Not To Be Regarded as Non-Cohesive and Granular—Tests Cited To Support New Theory

By Lazarus White
President, Spencer, White & Prentis, Inc., Engineers and Contractors, New York City

RECENT investigations show clearly that earth in foundations behaves as an elastic solid of low strength and low shearing value, and much progress in the proper understanding of foundations has been made when the subject has been approached with this thought in mind. The principle involved is simply the treating of earth as any other structural material, ascertaining its relation of stress to strain or, in common parlance, of loads to settlements.

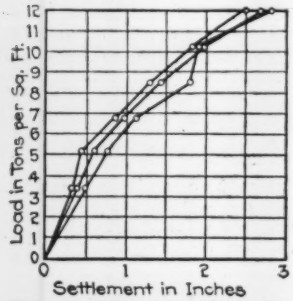


FIG. 1. BEARING TEST ON EARTH UNDER FARMERS LOAN AND TRUST BUILDING

Progress has been made in the art of securing earth samples by borings and test pits, as well as in placing footings at any desired depths by sheeted pits and pneumatic caissons. But these methods have been classed as branches of an art, and it has been claimed that not even a beginning has been made in a real science of foundations. Various attempts have been made to classify soils minutely as different varieties of sands, clays, etc., and to ascribe a definite bearing value to each class, but this has led to confusion. In extensive mathematical investigations earth has been considered as a granular material without cohesion and with different angles of repose. The result has been to increase the confusion and to discourage investigation into problems which are of fundamental importance in the design of many engineering structures.

It is believed that establishment of the principle that earth under load behaves as an elastic solid is a real beginning in the science of foundations. This article presents a discussion of tests supporting the above principle, together with a description of its application in developing a system of foundation construction.

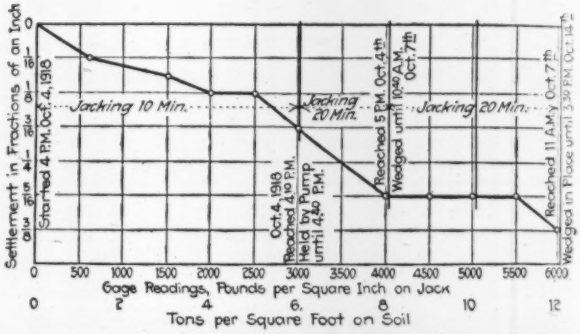

Settlement in Fractions of an Inch
Jacking 10 Min.
Jacking 20 Min.
Started 4 P.M. Oct. 4, 1918
Oct. 4, 1918 Reached 4.40 P.M. Held by Pump until 4.50 P.M.
Reached 5 P.M. Oct. 4th Wedged until 10.40 A.M. Oct. 7th
Jacking 20 Min.
Reached 11 A.M. Oct. 7th Wedged in Place until 3.50 P.M. Oct. 14th
Gage Readings, Pounds per Square Inch on Jack
Tons per Square Foot on Soil

FIG. 2. BEARING TEST ON EARTH IN OPEN GROUND

The bearing value of soils should be stated in terms of settlement—5 tons for a settlement of 1 in. for instance. Such tests can be readily conducted and plotted as in Fig. 1, which represents a test carried out at the Farmers Loan & Trust Co. Building, New York City. The soil, which was well compressed and undisturbed, consisted of 88 per cent sand and 12 per cent clay. The load was applied continuously and increased uniformly over the entire duration of the test (20 min.) by a 6-in. hydraulic jack. The bearing area was 4.1 sq.ft. Each curve represents the settlement at one corner of the bearing block.

A similar test was conducted in an open lot (see Fig. 2) for Armour & Co., McLean Long, engineer, at 14th St. and 10th Ave., New York City, from Oct. 4 to 14, 1918. The soil was coarse, sharp sand to a depth of 15 ft. below the filled ground. A 50-ton jack was used imposing a load of 8 tons per square foot for 65 hr. 40 min. and 12 tons for 7 days, 4½ hours. In this case a time element was also introduced to satisfy the Building Department requirement. By means of the gage a wide range of tests can be made quickly and much light thrown on the behavior of soils. A glance at the curve-

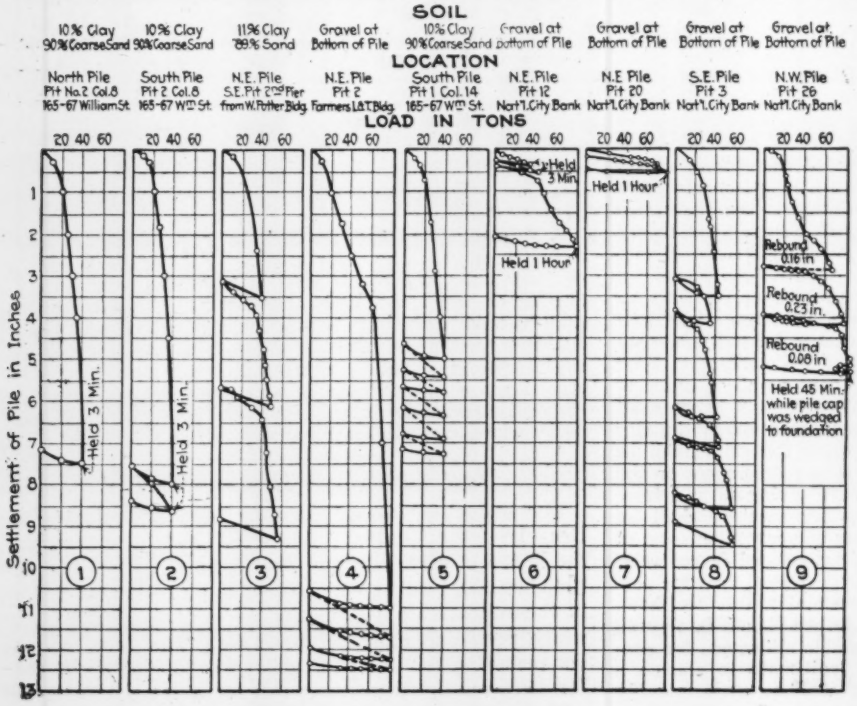

SOIL
10% Clay 90% Coarse Sand
10% Clay 90% Coarse Sand
11% Clay 89% Sand
Gravel at Bottom of Pile
10% Clay 90% Coarse Sand
Gravel at bottom of Pile
Gravel at Bottom of Pile
Gravel at Bottom of Pile
Gravel at Bottom of Pile
LOCATION
North Pile Pit No. 2 Col. 8 165-67 William St.
South Pile Pit 2 Col. 8 165-67 Wm St.
N.E. Pile S.E. Pit 2nd Pier from W. Potter Bldg.
N.E. Pile Pit 2 Farmers L&T Bldg.
South Pile Pit 1 Col. 14 165-67 Wm St.
N.E. Pile Pit 12 Nat'l. City Bank
N.E. Pile Pit 20 Nat'l. City Bank
S.E. Pile Pit 3 Nat'l. City Bank
N.W. Pile Pit 26 Nat'l. City Bank
LOAD IN TONS
20 40 60
Settlement of Pile in Inches
Held 3 Min.
Held 1 Hour
Rebound 0.16 in.
Rebound 0.23 in.
Rebound 0.08 in.
Held 45 Min. while pile cap was wedged to foundation

FIG. 2A. SETTLEMENT AND REBOUND CURVES FOR 14-INCH PILES

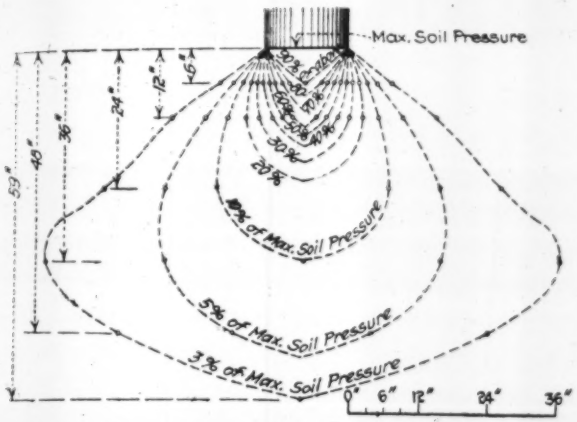


FIG. 3. LOAD DISTRIBUTION BY BULB OF PRESSURE

of Figs. 1 and 2 will show plainly that the earth has the properties of an elastic solid. This is shown still more clearly by tests, Fig. 2A, where much higher pressures were used. These tests were made under the direction of J. F. Greathead for the Public Service Commission. The curve plainly shows distinct elastic properties, including recovery or "rebound." But the settlement, on reapplication of the load, to a greater amount than the rebound was a rather unpleasant discovery for the underpinning specialists and led to further investigations.

About the time the above tests were made, some interesting tests were published in the *Engineering Record*, March 13, 1915, p. 330. These tests were made at the Pennsylvania State College on a large scale and several interesting curves were published. Graphically, the distributions of pressures were measured at various distances and depths from the load applied by a hydraulic jack, the resisting pressure being measured on a similar area of the bottom of a large box by a scale beam. Tests on different soils and with different pressures gave very similar curves, particularly for the greater depths and eccentricities. Using the Pennsylvania State College data as a basis, Mr. Greathead plotted the bulb of pressure under a 14-in. pile as shown in Fig. 3.

It is believed that thus for the first time the distribution of soil pressure below a footing was given qualitatively and quantitatively. A little study of the "bulb of pressure" will enable one to understand how a soil can take great pressures, the bulb merely spreading the load over such a great area that the unit pressure is reduced to a value that the soil can sustain without settlement. The bulb also explains rebound and resettlements. When the load is released, an elastic expansion of the bulb takes place, but in so doing it partly breaks down. It is formed again at a lower level by a reapplication of the load. An examination of the bulb of pressure discloses further interesting things, particularly the closeness of the different intensities of pressure near its top, and that in no sense has earth in this condition liquid properties and that it is a true solid. It shows also that a footing can be approached closely without encountering lateral pressure.

The formation of the bulb of pressure has been photographed by a camera placed before the glass front of a box within which sand was compacted by a superimposed block. An inspection of fine wet sand subjected to a pressure of 40 tons per square foot revealed that it became quite dry, had a vertical cleavage and in fact had been turned into an incipient sandstone.

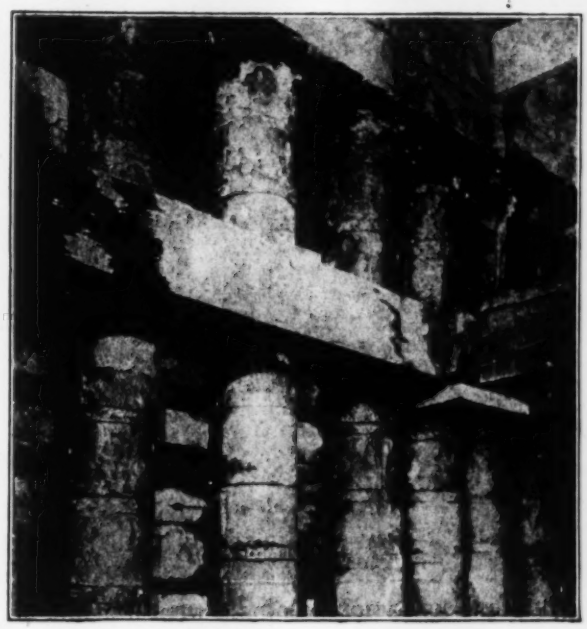


FIG. 5. PRETEST CYLINDERS IN UNDERPINNING FOR KUHN-LOEB BUILDING

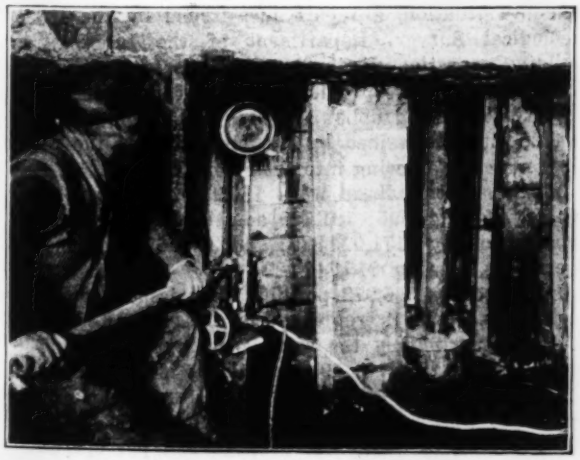


FIG. 4. JACKS MAINTAIN LOAD ON FOUNDATION PILES

The data shown in Figs. 1 to 3 were accumulated previous to 1916. Recent investigations of the joint committee on stresses in railway track of the American Society of Civil Engineers and the American Railway Engineering Association have disclosed much confirming evidence. They indicate that the ballast below the railway ties, whether of broken stone, gravel or sand, showed truly elastic qualities. The committee also found the pressures on the ballast at various depths below the ties and published a diagram of these pressures similar to, but not as complete as, that of Fig. 3.

A correct understanding of the action of a spread footing leads directly to an understanding of all other types of footing, such as piles and caissons. Each pile, cylindrical or tapering, forms a bulb of pressure. If the pile is cylindrical, the bulb is at the base. For a tapering pile the bulb extends along the pile but is on the same projected area as that formed by a cylindrical

pile of the same cross section. A group of piles forms a large spread footing through overlapping bulbs of pressure, which simply transfer the load to a layer of soil at the base of the piles. If the bearing value of the entire area is sufficient little settlement takes place; but if insufficient there will be a general settlement over the whole area. Placing more piles within the original area will do little good.

A splendid opportunity in 1915-17 was given for application of this recent knowledge. Only about 20 per cent of an unprecedented underpinning job on William St., New York City, had been completed, and the worst buildings had still to be underpinned by the use of 14-in. sectional steel piles. The assessed valuation of these buildings was about $40,000,000 and the frontage 3,000 ft. It was seen that if the "rebound" were eliminated,

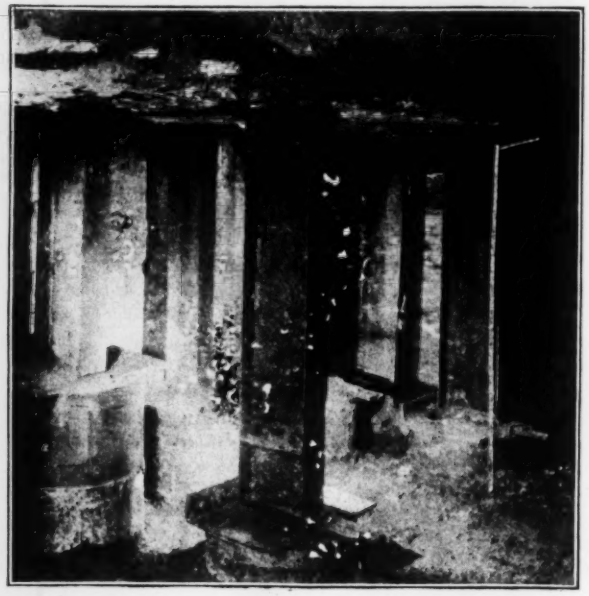


FIG. 6. FOUNDATION CYLINDERS WITH WEDGING POSTS IN PLACE

the problem would be solved, and the bulb of pressure retained permanently below each sectional pile. To accomplish this result (see Fig. 4) the load of the jacks was maintained on the pile until the wedging beams were securely placed, the rebound being held down to about ⅛-in. whereas the full rebound is about ⅜-in. Reapplication of the loads showed no settlement of the pile up to the original test load, but only a negligible elastic compression of the bulb. Observations were kept over long periods by means of the Berry sctrain gage with the same result.

The first application of this method gave wonderfully good results, the Bank of America settling only ¼-in. during the whole process of going under the footings, underpinning piers up to 600 tons in weight, cutting off half of the footings and excavating 20 ft. below them. The Kuhn-Loeb Building, a 20-story structure, was underpinned in a similar way, the front row of piles being almost entirely exposed, as shown in Fig. 5. In this method of underpinning the loads were carefully computed and each 14-in. cylindrical pile was assigned a load of about 40 tons, but to give a definite factor of safety each pile was tested to about 60 tons.

The application to a new building came next at William and John Sts., where a stratum of fine sa[illegible] extends to a depth of about 140 ft. A new 20-story bui[illegible] ing was projected, but would have to be at least t[illegible] stories high within a few months after the property w[illegible] acquired so as to anticipate the zoning law, which o[illegible] that street would permit of an 11-story building onl[illegible]. All the material below the footings was quicksand. The architect observing the success of the underpinning methods along William St. appealed to the contractor's engineers to help him out, which they did by devising what is now known as the "Pretest" system of foundation. This system applies the knowledge acquired, as described in this article, and also the technique of underpinning. But knowledge is science and technique is art, and science and art should go hand in hand.

This work presented three unusual features: (1) The erection of a building simultaneously with the construction of the foundation; (2) the securing of a foundation with a definite factor of safety; (3) the reduction of settlement to low limits. It is believed that all these were accomplished with resulting economy for the owners of the building. The methods employed were described in the *Engineering News-Record* of Dec. 6, 1917, p. 1060. Briefly, backfilling was placed over the cylinders, with wood posts resting on the cylinders and embedded in the fill, a concrete girder being then cast on this backfilling and posts. The steel grillages were then placed and erection was started. As the work progressed, the backfill was removed and the cylinders were loaded successively by hydraulic jacks. When the desired load was reached, I-beam posts were placed between the pile head and the base of the girder. After thse had been wedged tight the jack was removed and the I-beams were concreted.

The erection progress was slower than had been expected, so that by the time the building was eighteen stories high all the cylinders had been tested, wedged and corrected. A group of cylinders with wedging posts ready for correction is shown in Fig. 6. A 50-ton load was assigned to each 19-in. cylinder, but each was tested to 70 tons to give a factor of safety. Similar foundations have been used in three additional cases.

It is believed that the "pretest" system of foundations owes its success to the proper application of the principles set forth in this article.

Building Activities in 1919

In view of the present unusual conditions in the housing situation, a report just issued by the U. S. Geological Survey, Department of the Interior, on building operations in the larger cities of the country in 1919, by Jefferson Middleton, is of interest. This report shows the number and cost of buildings erected in 128 cities, classified by the character of the principal material entering into their construction.

In these cities there were 186,933 new operations, costing $951,047,495; 131,729 additions, alterations, or repairs, costing $171,024,832; and 20,846 miscellaneous operations, costing $15,246,422.

In 141 cities 365,972 permits were issued or buildings erected in 1919, representing a cost of $1,302,998,607. Approximately the same cities reported 210,538 building operations in 1918, costing $430,041,365, and the record for 1919 thus shows an increase of 155,434, or 74 per cent, in operations, and of $872,984,242, or 203 per cent, in cost. The average cost per operation in 1919 was $3,560.

Trend of Highway Development —A Survey

Indiana's Practice

THIS is the eighth of a series of articles on the highway situation. It discusses chiefly the task of bringing, by maintenance, the old gravel and dirt road system into a serviceable state prior to final improvement.

The ninth article of the series will appear in next week's issue.—EDITOR.

INDIANA this year has regenerated a large mileage of its state highway system by maintenance. Important roads have been paved and pavement construction will be extended, but maintenance is the more notable accomplishment; (1) Because it has involved

ONE TYPE OF INDIANA HIGHWAY TAKEN OVER FOR MAINTENANCE

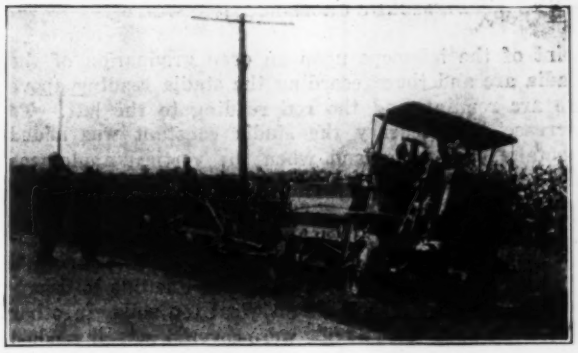
reconstruction to an extent which ordinarily is not comprehended in maintenance; and (2) because it had to be inaugurated by an organization in process of creation under limitations of directing personnel which have thrown an ungenerous burden on the department's heads. As a working organization the state highway commission is virtually only eighteen months old and all of the routes of the state highway system have not been definitely located. These facts also have affected maintenance practice.

In 1920 Indiana took over approximately 3,600 miles of highway, to be improved and maintained by the state. Except for a small scattered mileage of pavement, these state highways were gravel or earth roads. Ordinarily the gravel roads, except on certain main routes, were not of modern high-class gravel construction; many of them were little more than gravel surfaced trails. Formerly these roads had been maintained by the counties. With state control in prospect, the counties had for a season or two done little maintenance work. When, therefore, the state highway department assumed the task of maintenance, the roads as a whole were in bad repair. Maintenance in many cases involved virtual reconstruction, including widening, ditching and resurfacing.

Obviously, highway maintenance, as practiced in 1920 in Indiana and as it must continue, under present plans, to be practiced until the roads are substantially reconstructed is a quite different task than it is in states having gravel and earth roads completed to permanent grade prior to maintenance. Emphasis of this fact is important, if a clear conception is to be had of the trend of highway development in Indiana, and this emphasis is given best by views of actual maintenance operations. The distressing state of repair shown by Fig. 1 was not common but it was encountered and many miles of road had to be provided with shoulders and ditches, as shown in Fig. 2, before maintenance in the true sense was possible.

Organization for maintenance is based on the patrol system. Under the chief engineer of maintenance are five division engineers each in charge of a territorial division of the state roads. Each division engineer has under him five or more superintendents each in charge of half a dozen or more patrolmen, a mechanic and two or more special gang foremen. The equipment of a patrol is a motor truck, a light blade grader, two drags, a plow and small tools. In the extensive reconstruction work of this year gangs have often been grouped and labor and equipment exchanged, but the plan permits of true patrol organization involving personal responsibility for distinct sections of highway as the roads are put in shape for maintenance.

The funds available for maintenance are the automobile license fees and the inheritance tax. Construction is financed by a one-mill tax on real property. At present the future amount of this fund is in doubt, it being held by the tax commissioner that the tax applies only on the original assessed valuation which is about half the present assessed valuation. Legislation will be required to clarify this situation. With taxation on the full valuation, construction funds in 1922 should approximate $12,000,000. The total Federal aid available is $4,726,239 and of this $2,724,271 is now covered by project agreements. In county work this year, there have been unusual financial difficulties. Counties in many instances have been unable to market their low



MAINTENANCE GENERALLY INVOLVED PRELIMINARY DITCHING

interest bonds and projects have been held up often after contracts had been let and construction had begun. It is, for these various reasons, the general opinion that clarifying legislation is needed to place highway development on a definite basis financially.

With about 210 miles of pavement under contract a little over 75 miles were completed in 1920. Transportation shortage of materials explains the small percentage of construction. The progress on bridge work has been even less favorable. Transportation difficulties in obtaining commercial materials is leading to serious study of local pit development and, particularly, of methods of using pit-run gravel. The specifications now hold rigidly to definite ratios of sand and gravel, so

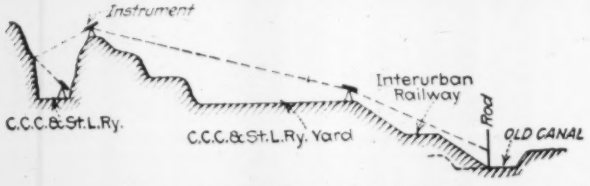
their modification in respect to aggregate mixtures is among the possible developments. Paving methods, as in most other states, continue along old lines.

Indiana is in the process of finding herself in state highway improvement. Her greatest obstacle appears to be difficulty in appraising the magnitude of the task before the highway department. A sort of penury has been practiced, therefore, in building up the technical directing organization which has put too heavy a burden of detail on the directing heads. Breadth of organization needs to be secured. With legislation which will clarify uncertainties in financing road work, this policy will set highway development in the ways of modern practice.

Cross-Sectioning With Stadia Arc

By F. W. Medaugh
Dept. of Engineering, Johns Hopkins University, Baltimore, Md.

IN MEASURING cross-sections for the railway valuation work of the Interstate Commerce Commission the value of the Beaman stadia arc has been demonstrated. A light instrument was used, consisting of a telescope mounted upon a small revolving plate supplied with a central circular bubble and fitted to a head similar to that used for leveling plane tables. Attachments for the telescope were the bubble, clamp, slow motion screw and stadia arc attachment. Readings were taken in the customary manner by setting the zero



DIFFICULT CROSS-SECTION WORK

point of the telescope upon an even graduation of the stadia arc and then recording the stadia reading above the arc reading and the rod reading to the left. To increase the accuracy the stadia constant was added mentally each time, and when the vertical angle was large the rodman held a small level against the rod in order to have it plumb.

The chief difficulty was indefiniteness of the original ground line. At the top of cuts the original examination showed generally a dark line due to decaying vegetable matter of the original top soil. In other places the upper toes of fills were covered by soil washed from the surrounding hillside, rendering it practically impossible to tell where the original surface had been. The rodman then held his rod at the present toe and the recorder added to the rod reading an amount based upon the topography of the surrounding slopes.

A recorder, an instrumentman and a rodman composed the cross-section party. In rough country the recorder carried a light 6-ft. rod and gave readings on one side of the roadbed, thus increasing the speed of the party. The readings were recorded on sheets kept in a large loose-leaf binder, a carbon copy being made for the railroad. On small cuts and fills many of the readings were taken with the telescope horizontal. The instrumentman then mentally subtracted the height of the instrument (usually 5 ft.) from the road reading and called out the result to the recorder. Thus the notes showed the cut or fill with respect to the base of rail.

All readings taken with the telescope inclined were reduced in the office with the aid of a table, but as most of the shots were comparatively short it was not necessary to have a very extensive reduction table. The stadia distances from zero to 50 ft. were placed in the column to the left, while the Beaman arc readings were placed at the top of double columns, from which the horizontal distance and difference in elevation could be read directly. When calculating the difference in elevation, the computer had to take into account the rod reading and the height of instrument, and had also to remember that Beaman arc readings between zero and 50 gave negative values, while readings between 50 and 100 gave positive values. To facilitate the use of the table it was mounted on a large wooden roller in such a way that the distances and elevations moved past the stationary Beaman arc readings as the operator revolved the roller.

In level country it was questionable which was the better method of taking measurements, by stadia and Beaman arc or by hand level and cloth tape. The former method was a little more accurate in reading elevations, but was not quite as rapid, even though many of the instrumentmen were extremely expert. In many light fills made from side borrow by scrapers there was no sharp line of demarcation between side of fill and side of borrow pit. Measurements could be made then much more rapidly with the hand level and tape, for the distance could be taken to the approximate toe of fill and the rodman could then hold his rod on the original ground on the far side of the borrow pit while the elevation was being read.

If the country was at all rough, however, the use of the stadia and the Beaman arc was found in most cases to effect a decided saving of time, in special cases at least 50 per cent. When double lines of box cars obstructed the sights it was a simple matter to set the instrument on the roof of a car to take the section, being careful to locate the position of the instrument with respect to the center lines both as regards distance and elevation. This procedure was specially valuable in yards where there was constant shifting of cars so that measurements with a tape would be attended with danger and loss of time.

A specially difficult problem solved successfully in this way was the measurement of the grading quantities of the Big Four yards at Wabash, Ind., as shown in the accompanying view. The main line here was in 40 to 50 ft. of cut and was separated from the yard by a mass of rock. The yard tracks were partly in cut and partly on fill, the fill sloping down to an interurban line and then into the bed of an abandoned and partly filled canal. The computers were furnished by the railroad with notes giving the original ground line and the closeness with which this line fitted the section taken spoke well for the accuracy of the work.

South American Ties for Pennsylvania R.R.

Investigation of the hardwoods of Central and South America as material for ties is to be made by the Pennsylvania System in view of present high prices of ties in this country, the cost and life of the tropical woods being the main points. Under normal conditions this railway requires from 5,000,000 to 6,000,000 ties annually and the average net cost has risen 100 per cent since the beginning of the war, according to an official statement.

An Analysis of the Proposal to Establish a National Department of Public Works

By Lieut.-Col. C. O. Sherrill
Corps of Engineers, U. S. Army, Washington, D. C.

THE proposal to create a Department of Public Works has been urged for many years by members of the engineering and contracting professions, with the avowed purpose of bringing under one head all engineering and construction activities carried on by the U. S. Government. Although advocated for many years by individuals, it is only since April, 1919, that this question has been actively taken up and advocated by engineering societies and contractors' associations with a carefully organized propaganda directed by the National Public Works Department Association. The activities of this association have led to the introduction in the U. S. Senate and House of Representatives of a bill to create a Department of Public Works, known as the Jones-Reavis Bill (S-2232, H.R.-6649).

The most important provision of the bill consists in the conversion of the Department of the Interior into a Department of Public Works, and the placing in that department of all engineering, construction and related activities now distributed throughout the various departments and independent bureaus of the Government. It also provides that the secretary of this department must be appointed from the engineering profession; that each assistant secretary must also be specially qualified by training and experience for his particular service; that the tenure of the assistant secretaries in office is for life or good behavior, subject to removal only for inefficiency or malfeasance in office, or physical disability. These assistant secretaries are to be charged respectively—one with all governmental matters of engineering design and construction; one with all governmental architectural design and construction; one with all governmental scientific work and surveys; and one with all governmental land and legal matters. In other words, one assistant secretary must be an engineer; one an architect; one a mapping expert; and one a lawyer.

Objects of Bill

The ends to be accomplished by this bill as set forth in the propaganda of the Public Works Department Association are briefly as follows:

To create an industrial organization along the lines followed so successfully by American industries; to secure centralization with resultant large economies of overhead; to eliminate rivalry and competition for appropriations; to provide a special technical organization to do engineering work for other departments; to secure standardization and simplification of Government contracts and specifications; to provide a complete business organization available in case of war for its construction activities; to render aid to the budget system; to serve as a regulator of our national industries; to provide a means of broader training for the Corps of Engineers, U. S. Army; to bring the United States into line with other important countries in having a Public Works Department; to provide for co-ordinated technical research.

The advocates of the Department of public works cite, as the principal reasons for the creation of such a department, the following: That there would be improvement in the administrative organization of the national government; that efficiency would be promoted in overhead administration, that duplication of effort would be avoided, with better utilization of plant and personnel, and with the standardization of specifications and procedure; that economy and efficiency of the other departments relieved of public works would be promoted; that a permanent corps of civilian engineers would be created that would be of great public advantage both in peace and in war.

It is argued that the administrative branch of the federal government has grown up piecemeal, on no well-thought-out plan, with the result that as the government activities have extended their scope, many inconsistencies of assignment of functions have resulted, with much overlapping and lack of co-ordination. One of the strongest points made by the advocates of this measure is that there will be a single head to all the related activities of the Government along engineering and construction lines, apparently allowing the elimination of duplication not only of work done, but of organization, personnel and plant.

Arguments Against the Creation of the Department

The principal arguments against the creation of this Department of Public Works have been well summarized by the Chamber of Commerce of the United States in its referendum submitted to the component chambers of commerce throughout the United States, March 30, 1920, which resulted in the rejection of the proposal. These are briefly as follows:

(a) The proposal is too vague and indefinite for adoption, especially as definiteness and exactness are supposed to be fundamental qualities of proposals made by engineers.

(b) While reorganization of all the activities of the federal government might well be undertaken by Congress in the interest of logical arrangement, such reorganization should be based upon a careful examination of the governmental functions for which these departments were brought into being, and not by a piecemeal consideration, as proposed by this bill, such an effort having an inevitable tendency to create many new non-essential departments of government at a time when the number of Cabinet officers is so great as to form an unwieldy body. Instances of these new departments having an equal or greater merit than the Public Works Department are: Department of Education, Department of Public Health, Department of Public Welfare, Department of Air Navigation, Department of Transportation. The evil results of the proposal are already evident in the effort to prevent the placing of all construction activities of the War Department in the hands of the Corps of Engineers by the perpetuation of an additional and unnecessary Construction Division within this department.

(c) The inefficiency of the present arrangement of engineering and constructing services has not been demonstrated.

(d) Economy would not be promoted, but expenditures would, on the contrary, be increased. Each of the bureaus of this new department will inevitably build up a large organization of clerks and other employees for itself. Instead of allowing each department to do the minor engineering work incident to its principal function, the Public Works Department will have to be called in to build each item, no matter how trifling, as for instance, a few miles of telephone line for the Forest Service, which could under this bill no longer be constructed by its own employees when not otherwise engaged.

(e) The Public Works Department at best would be a misnomer, as the United States does not have public works of the kind described by the proponents of the measure of

sufficient importance and suitable for transfer to warrant the setting up of a new Department of Public Works, nor to justify its head having a place in the Cabinet. This department suggests strongly public ownership and operation of utilities not now apparent.

(f) The governmental departments can in other and more appropriate ways secure competent engineering services. This appears to be an effort to increase the permanence, compensation and emolument of one class of government employees, viz., engineers, at the expense of all other classes.

(g) Governmental organization must for success be functional, and engineering is not a function, but rather one of the branches of technique of governmental functions. Engineering is a profession which exists solely for the assistance it can render in the accomplishment of purposes wholly apart from engineering. The head of a government department utilizes professional services of lawyers, engineers, accountants and of various other professional and technical men to assist him in carrying out the functions of his department, but there is no reason why these functions should be subordinated to any of these branches of service technique.

(h) There are many other special objections that will arise from such a concentration of engineering work to be done for other departments, an example being the Office of Indian Affairs, whose function is the guardianship and trusteeship of Indians while they are being brought to the status of citizens. This trusteeship controls more than a quarter of a billion dollars' worth of property. The absurdity of having the trustee withdraw altogether in favor of a lawyer or engineer because legal or engineering questions from time to time have to be settled by the trustee, is self evident. Responsibility for the performance of governmental functions should be made more definite, not dispersed. If the execution of engineering or construction work is placed in one department, and a purpose to which the work contributes in another department, there will inevitably be a diminution of official responsibility upon the official charged with the accomplishment of the purpose. Giving the department head his own professional assistance may mean some duplication, but the advantage to the public in having a public duty expeditiously and properly fulfilled and in having some one person whom it can hold exactly responsible for any failure far outweigh any such duplication.

At first glance and on theoretical grounds solely, the proposal to establish a Department of Public Works to handle all the construction and engineering activities of the government is one that naturally makes a strong appeal to the public at large. To say that one, rather than a number of different heads, shall direct all work of similar nature under the government is a principle to which no one can consistently object, unless there are other and more potent reasons why such concentration should not take place. Since all engineering and construction activities have a certain similarity, it might require but little argument to convince the uninformed on matters of govermental policy that a separate department to handle all these matters should be established. I am prepared to go even further and say that if the disadvantages that will result from such consolidation are not greater than the advantages to be secured, then such consolidation might well be made.

Two Classes of Engineering Work

In drafting the bill for the Department of Public Works, its advocates appear to have lost sight of the two fundamentally distinct classes of engineering and construction works carried on by the government, and in failing to make this distinction they have committed themselves to an illogical grouping of bureaus in the proposed department. These two distinct classes of activities are:

(a) Engineering and construction activities carried on for the public at large and as the primary function of the bureau of service concerned, *i.e.*, the principal business of the bureau and the reason for its existence.

(b) Those engineering and construction activities carried on as mere incidents to the primary functions of the departments or bureaus which execute these functions. These incidental activities vary in magnitude from the most minute detail to projects involving hundreds of millions of dollars, and yet, notwithstanding their magnitude, are after all only incidental to some other primary function.

In the effort of the advocates of the Public Works Department to make out a good case for a separate department, they have thrown together a heterogeneous lot of slightly related independent and incidental activities under one head, with little regard at all to the real governmental functions to which these activities are only incidental. Take the case of the Bureau of Indian Affairs and the Board of Indian Commissioners; this bill proposes to place these bureaus under the Department of Labor, while taking from them their engineering, construction and survey work carried on as an incident of caring for the Indians. In other words, the Bureau of Indian Affairs is the trustee for the Indians and is responsible to Congress for their welfare, and yet it is at the outset to be deprived of some of the most essential means for the accomplishment of that end, and with no other argument than that all engineering and construction activities should be grouped together under one independent head. The undesirability of such a proposal would be apparent if it were applied to a trustee in private life, for instance, to the trustee of a minor child. Who could imagine a case where a trustee of a child should not direct all legal, moral or educational activities necessary to care for the child's interest to the time of its maturity.

Bill Held to Be Inconsistent

The proposed bill is equally inconsistent as to what is omitted therefrom, as for example, one of the most costly activities of the Interstate Commerce Commission is the valuation of railroad properties, largely an engineer function. Evidently the advocates of this measure could hardly justify even to themselves the taking away of this important adjunct to the primary functions of the Interstate Commerce Commission, and yet they have done other things even more radical and more detrimental to other departments. For instance, they propose to place the construction work of the Army in this Department of Public Works on the ground that its work is largely of a civil engineering nature, apparently ignoring the fact that the Army does not construct quarters and storehouses solely to get something built, but only that troops and supplies may be protected from the weather and be in constant readiness for war; or in other words, the army's construction work is only incidental to its business of defending the nation.

The General Land Office, however, is left in the Department of Public Works, although its engineering and surveying functions are solely an incident, though an important incident, to its primary function of administering the public lands of the United States for the benefits of settlers. The Reclamation Service is also left in the proposed Department of Public Works, although the building of dams and drainage ditches is an incident only to the administration of reclamation projects and laws for the benefit of settlers on otherwise arid government land. The National Park Service is left in the Department of Public Works, as if its prime object were the construction of engineering monuments rather than the administration of the national parks of the United States as playgrounds for the pleasure and benefit of the people at large.

These inconsistencies in assigning activities are no-

where more obvious than in the assignment of river and harbor improvement to the Department of Public Works, while leaving the Bureau of Lighthouses under the Department of Commerce. No two activities of the Government are more closely related than are these or could be combined under on head with greater advantage. In fact many of the lighthouse districts have their construction and repair work done at this time under officers of the Corps of Engineers in charge of river and harbor work.

The example most frequently given by the Department of Public Works advocates of the inconsistency of the present arrangement of governmental construction activities is that of the Supervising Architect's Office in the Treasury Department. The real reason why this is under the Treasury rather than any other department is that this department is the largest governmental user of public buildings in our cities for custom houses, sub-treasuries, Internal Revenue offices, Federal Reserve banks, etc. What is more appropriate than that the Secretary of the Treasury should direct the construction of the buildings he needs in his business?

Arguments for the Department

The cases above cited are but a few of the many inconsistencies that result from this effort to bring together many apparently similar but actually dissimilar activities to create a Department of Public Works; and the reason for these inconsistencies arises from the fact that the advocates of this measure have failed to realize that there is one and only one vitally important reason for the creation of governmental departments and bureaus, and that reason is that some essential governmental function may be carried out for the benefit of the people of the country. The construction of engineering works cannot by any means be classed as a function of government, but only as one of the many means used by the various governmental departments in carrying out their proper functions. This is clearly shown in one of the most prominent of the arguments for this department, viz., that there are nine federal departments, thirty-five bureaus, and four unattached commissions now engaged in engineering and construction work. This means that every one of the government departments and nearly all the bureaus and commissions find it necessary, in the execution of their primary governmental functions, to do a certain amount of engineering and construction work, just as most of them find it necessary to do a certain amount of legal, educational, commercial and research work, but if they are to be held responsible for accomplishing the purposes for which they are created, then they must be given all of the essential machinery, including construction, for the successful execution of these functions.

Having had some experience as an engineer in the Army, engaged on construction work, and having also been in command of troops for whom construction work is done in the Army, I realize how difficult it is to secure a proper consideration of the object for which construction work is done, even in a small organization and where the engineering and using services are in closest co-operation and associated under one army head. To secure the class of construction work necessary for the different government departments through an entirely independent and outside agency, such as this Department of Public Works, would be almost impossible of accomplishment. Such a roundabout and unworkable arrangement would cause only delays, annoyance and interference with governmental functions.

An Assumed Case of Red Tape

Let us assume a particular case: The Army has a battalion stationed at Fort Huachaca, Arizona. The battalion commander finds that in the administration of his battalion it will be necessary for him to have a company barrack. In order to get this through the Public Works Department he would report the necessity of it to his army department commander at San Antonio, who in turn would report the matter to the War Department. The Secretary of War would in turn report to the Secretary of the Department of Public Works that a barrack is required at Fort Huachaca. The Secretary of the Department of Public Works would transmit this information through his various intermediate divisions down to his office nearest to Fort Huachaca. This official would then made a survey and an estimate of the amount of money involved in this project, and if he were an official of the best type, would consult with the battalion commander to see if their views agreed. If, however, he did not care to co-operate in this way, he would make up his plans independently, send them back through all the various intermediaries to Washington, and so on to the head of the Public Works Department, who would submit them to the War Department, and thus they would go back once more to the battalion commander, to find out if the plans were adapted to his requirements. It can be readily seen from this simple illustration that it would be impossible to get the desired results by a segregation of construction activities in a separate department, independent of the agency for which the construction is being done.

But the segregation of activities in the proposed department goes much farther than this. In the department itself there are to be four main branches, each under an assistant secretary appointed for life. Before a cantonment for troops under the Secretary of War can be built by the Secretary of Public Works, his assistant secretary "A" must procure the land and do all necessary legal work, assistant secretary "B" must make the required surveys, and assistant secretary "C" must then make the necessary plans. If any architectural design is involved, assistant secretary "D" must be called upon to do this before assistant secretary "C" can begin the work of construction. Before the cantonment would be built under this arrangement the war would be over or the particular battalion out of the service due to exposure.

Engineer Corps Menaced

The Public Works Association has devoted most of its attention for the past year and a half to the Corps of Engineers, U. S. Army, in its propaganda for a Public Works Department, without a rejoinder in the public print from that conservative organization up to this time. In fact, a reading of the bill quoted above discloses that practically as much space is devoted in the bill itself to the destruction of the Corps of Engineers as is given to all the other construction agencies of the government combined. It will also be noted that whereas all other construction agencies of the government are taken into the Department of Public Works bodily, without change of their organization, in the case

of the Corps of Engineers the transfer is arranged so as to take away completely its administrative control over construction activities, allowing such officers of the Corps of Engineers as the Secretary of Public Works may deem necessary to be detailed by the Secretary of War for temporary duty for instruction purposes only in the new department. This proposal to take away from the Corps of Engineers its diversified construction activities is moreover emphasized in all the literature and propaganda that has been issued by the Public Works Association, making it appear that this proposal is aimed more at the destruction of the Corps of Engineers than for the general good of the government as a whole.

In a thirty-page pamphlet of propaganda issued by the Public Works Department Association, approximately five pages are devoted to explaining why the Corps of Engineers must be destroyed. This is advocated in spite of the long and honorable record of achievement of the Corps, free from political influence and graft, dating back to Revolutionary days and extending down to the building of the Panama Canal and to its construction exploits in France. The questionable ethics of these attacks on the Corps of Engineers by the Public Works Department Association seem entirely unworthy of the professional men by whom they are advanced.

Again, the advocates of this measure are absolutely inconsistent, for while urging in one breath the taking away from the Corps of Engineers of the construction activities with which it has been charged by Congress for over a hundred years and which it has carried out with the cleanest of records, this association, in the next breath, to secure efficiency proposes a system of tenure of office practically identical with that in the Corps of Engineers and differing solely in the fact that the officials in one case are commissioned officers, subject to all the dangers and disabilities of the military service, and in the other case are officials of this Public Works Department permanently in Washington. Section 7 of this bill undertakes to make the tenure of office of the assistant secretaries as permanent as is that of the officers of the Corps of Engineers, but with none of the advantages to the government of the latter, due to the possibility of relieving an unsatisfactory engineer officer from his construction duty without the necessity of the elaborate procedure prescribed for removing one of the assistant secretaries.

Another of the arguments used by the advocates of this measure is that it will provide an organization of trained engineers, available for use in war, which is what the government secures much more efficiently under its present system of using the Corps of Engineers to as great an extent as possible on the construction of essential public works in time of peace, in view of the military as well as civil engineering training of this body. When these peace-time construction activities are suspended at the outbreak of war, the Corps of Engineers is free to carry on all needed construction work of the Army in the theatre of military operations and in the United States.

Engineering Council's Committee on Military Affairs, realizing the importance of utilizing the army engineers on public works to the fullest extent possible in peace, as a preparation for war, recently enunciated the following principle:

> But the bringing together of the two great divisions of engineering science, military and civil, is only partly done when there is extended to civilian engineers the opportunity for gaining experience as military engineers. The full result will be attained when the military engineers in a corresponding manner are given the opportunity to become experienced as civil engineers. To enable the members of the Corps of Engineers to gain experience in all branches of civil engineering they should have opportunities for service on as much as possible of the general construction work done by the Federal Government, and not be confined to river and harbor improvements, as has been the custom. In addition to this, members of the corps should be assigned for temporary employment with state highway commissions or private corporations such as railway companies, metallurgical establishments, large contracting firms or factories where machinery, electrical devices and other forms of manufactured articles, in which engineers are interested, are produced and where members of the corps can become acquainted with all phases of practical operation.

This would clearly indicate that not only should the Corps of Engineers continue to execute the public works functions which it has successfully executed throughout the past, but that, in the interest of economy and preparedness for war, it should be given added duties of this nature whenever not decidedly disadvantageous to the interests of the government to assign it such additional duties.

The Corps of Engineers is a body of technical men of high standing, poorly paid but honest, whose lives are devoted to the public service, free from political influence; and no possible rearrangement of government functions can ever do more than to secure a similar high quality of service from government officials, whether commissioned or civilian.

In conclusion, it is believed to be established that there should be no Department of Public Works created as a new department or out of the Department of the Interior; that there is a possible necessity of a general reorganization of the government departments as a whole, but that any such reorganization should be based on governmental functions rather than on engineering technique; that the Corps of Engineers should continue as in the past to be charged with the execution of public works of construction to the fullest possible extent, in the interest of honesty, economy and preparedness for war.

Investigation of Drill Steel Undertaken

The Bureau of Mines is taking up actively an investigation of drill steel. Many users of drill steel feel that the improvements in that product have not kept pace with the improvements in drilling machines. The matter has been the subject of recent conferences between Dr. F. G. Cottrell, the director of the Bureau of Mines, D. A. Lyon, supervisor of experiment stations, and bureau specialists with representatives of various types of mining enteprises. The testimony of users in the districts where the rock is hard is wholly to the effect that the failure of steel has become a very serious problem, due to the loss of time on the part of high-priced labor.

B. F. Tillson, of the New Jersey Zinc Co., has made a special study of the causes of breakage in drill steel and will co-ouerate with the Bureau of Mines in the study of the problem. Mr. Tillson's investigations lead him to believe that the blows of the drill hammer set up vibrations comparable to sound waves and that nodes are caused by the concentration of these waves at certain points in the drill. This leads to prompt fracture. When a flaw or sand hole comes within the area of concentrated wave effect, the failure of the drill takes place almost immediately.

The Bureau's specialists, who are to be assigned to this problem, will be sent to the manufacturing plants to discuss the matter with officials there. A collection is to be made of broken steel so that the breaks may be studied.—*Engineering and Mining Journal.*

Irrigation Water Divided Between United States and Canada

Under International Agreement Flow of St. Mary and Milk Rivers Systematically Shared by Montana and Provinces

By Benjamin E. Jones
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Controversies over the division of irrigation waters in the western United States are frequent. Similar controversies arose on the St. Mary and Milk Rivers, in Montana and in Alberta and Saskatchewan, Canada, previous to 1909, and the fact that the contending parties lived in different countries did not make it easier to settle the dispute. This article will tell how an amicable adjustment was effected by an international treaty agreement for a division of the flow of the two streams between the two countries by a joint commission and how the division is being made year by year under the joint supervision of the directors of the U. S. Reclamation Service and the Reclamation Service of Canada.

St. Mary River, in the Hudson Bay drainage basin, rises in the mountains of Glacier National Park, in Montana, and flows northward into Canada where its water is used for irrigation. Milk River, a tributary of the Missouri, rises in the low hills adjacent to the St. Mary River drainage basin, flows northward into Canada, turns east, and finally, after flowing 216 miles in Canada, returns southward to the United States. The size of the drainage basins of these two streams, as indicated by the accompanying map, might suggest that Milk River would yield the larger flow, but a study of the character of the two drainage areas, as illustrated in the photographs here reproduced, shows why the glacier-fed St. Mary is a much better irrigation stream than the Milk, whose upper tributaries reach only as far as the foothills of the Rocky Mountains and whose lower valley is a dry prairie. As a result, during periods of long-continued drought, when irrigation is most necessary, Milk River goes dry, while the snows on the mountain peaks that drain into the St. Mary are melted by the hot summer sun, and the maximum flow occurs at that time.

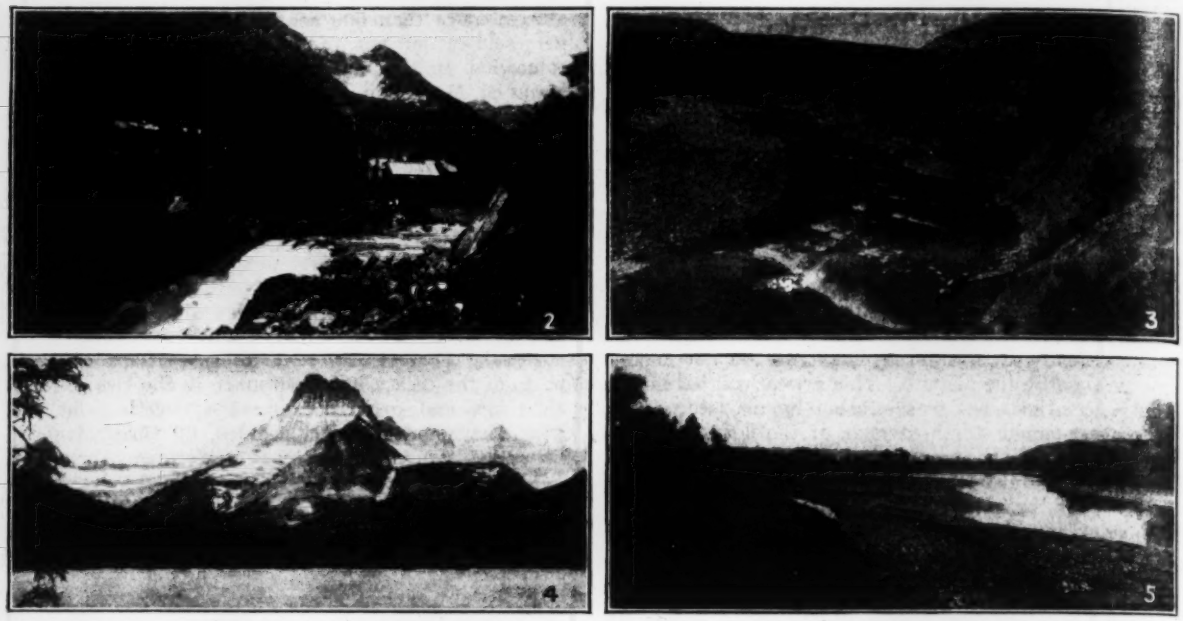
In 1901 or earlier the U. S. Reclamation Service, then a part of the U. S. Geological Survey, proposed to remedy this condition on Milk River by diverting the water of St. Mary River into the basin of the Milk, where it could be used to irrigate land in the lower end of Milk River Valley in Montana. After years of discussion an agreement between the United States and Canada was reached in 1909, and a treaty was made, under which the water of the two streams was divided equally between the two countries with one exception. To protect the rights of irrigators who prior to the making of the treaty had begun to use the water of the two rivers, a prior right to 500 sec.-ft. of St. Mary River, or so much of that amount as constitutes three-fourths of the natural flow of the river, was given to Canada, and a like priority on Milk River was given to the United States. As during the irrigation season there is nearly always more than 500 sec.-ft. in St. Mary River, and very seldom that much in Milk River, this exception was somewhat in Canada's favor. But Canada had been using St. Mary River water, and the United States that of Milk River, so this adjustment was probably adopted because it seemed to be the best one that was practicable. The actual division of the water was to be carried out under the direction of an International Joint Commission established by the treaty.

In 1917, the U. S. Reclamation Service completed its canal from St. Mary River to the top of the Milk River divide, and in May, 1918, the International Joint Commission met and issued a provisional order for the division of water for that year. A provisional order was necessary because different interpretations of certain parts of the treaty had been made in the two countries. Hearings and arguments on the questions at issue, which have not yet been decided, fill three large published volumes, besides a mass of testimony, briefs, etc., filed but not printed. A decision by the commission on the disputed points is expected soon. To carry out the orders of the commission, the United States named A. P. Davis, director of the United States Reclamation Service, as its representative, and Canada named E. F. Drake, director of the Reclamation Service of Canada. These two men, through their engineers in the field, divide the waters of the two rivers in accordance with the order of the commission.

FIG. 1. ST. MARY AND MILK RIVER DRAINAGE AREAS, OVERLAPPING INTERNATIONAL BOUNDARY

The smaller drainage area, because of its location in the mountains, has the larger yield. Under international agreement and jurisdiction the two streams are gaged and their flow divided (see text) between irrigation projects in the state of Montana and the provinces of Alberta and Saskatchewan.

The main engineering problem involved in the division is the accurate measurement of the quantity of water flowing in the streams and canals and the determination of the time required for water to travel given distances along the river beds and canals. For determining the flow of streams that cross the international boundary, the Reclamation Service of Canada and the U. S. Geological Survey have maintained joint stations since 1912, and there are at present nine such stations on these two rivers or their tributaries, and on the U. S. Reclamation Service canal diverting from St. Mary River. The cost of installation is borne equally by the two countries, and in the operation of the stations measurements are made at frequent intervals by engineers from both sides. At the end of the season the results are worked up jointly by the two organizations. In addition to these co-operative stations others are separately operated in the two river basins by the representatives of each of the two governments.



FIGS. 2 TO 5. VIEWS ON ST. MARY AND MILK RIVERS IN THE UNITED STATES AND CANADA

(2) Gage shelter and control on Swiftcurrent Creek at Many Glacier, Mont. (3) Gaging station on St. Mary River at international boundary. (4) Typical view of St. Mary River drainage area, early July. (5) Upper Milk River at Pendant de Oreille Police Post, Alberta. Note the contrasting character as regards water yield of the St. Mary River drainage area views (2), (3), (4) and the Milk River drainage area view (5).

After satisfactory measurements of the stream flow are obtained the problems involved in the actual division of the water under the commission's order are not difficult. First, it is necessary to determine the natural flow of St. Mary River, as Sherburne reservoir (see *Engineering News-Record,* Feb. 21, 1918, p. 366) constructed and operated by the United States, is on Swiftcurrent Creek, one of its principal tributaries. The water entering the reservoir comes mainly from two streams, so that by installing on these streams gaging stations equipped with water-stage recorders, it is possible to get a very close estimate of the daily inflow. Comparison of the inflow with the outflow gives the amount daily stored or released by the United States. The natural flow at the international boundary is then determined from the measured flow plus the amount diverted above, with proper allowance for storage.

Seepage losses in the St. Mary Canal are measured at three stations equipped with Stevens and Gurley gages. Measurements at these stations also show the amount of water diverted from St. Mary River to Milk River by the United States. As the seepage loss in the upper half of the canal returns directly to St. Mary River and can be rediverted by Canada, the records of the middle station on the canal, where it crosses St. Mary River, are used for purposes of division. The water received by Canada is measured at a gaging station at the international boundary. Canada also maintains stations showing the amount diverted from St. Mary River in that country and at a station near the mouth of the river showing the water not utilized for irrigation. The city of Lethbridge takes its municipal supply from the river near its mouth.

On Milk River the main determinations necessary are the natural flow of the river, the inflow from the tributaries, particularly the large tributaries from the north whose courses lie in both countries, and the seepage loss. An interesting problem, although it is not international in character, is the determination by the U. S. Reclamation Service of the natural flow of Milk River below Havre, Mont., allowance being made for losses by seepage and evaporation. The natural flow of Milk River during the irrigation season is nearly all subject to old claims of private companies and individuals, but the diverted St. Mary River water belongs to the Milk River project of the Reclamation Service. On Milk River stations are maintained on North Fork above and below the point where the St. Mary water enters, and the flow at the upper station combined with that at a station on South Fork of Milk River gives the natural flow at the upper end of Milk River. Farther down stream are stations at the town of Milk River, in Canada; at the eastern crossing of the international boundary, where the stream returns to the United States, and at Havre, Mont., above all diversions in the United States. During dry seasons those stations show the seepage losses in over 300 miles of river channel, for at such times there is practically no inflow between the upper and lower stations. During wet years a large number of tributary streams must be measured. The losses by seepage and evaporation in 1919 amounted to about 100 sec.-ft., out of 400 sec.-ft., flowing at the upper end of the river. During very hot spells this loss increases somewhat, and in fact the influence of temperature on losses is marked.

Other gaging stations are maintained along the international boundary on the principal tributaries of Milk River from the north, Lodge and Battle creeks and Frenchman River. To acquire general information for the Milk River project, the southern tributaries of Milk River are measured, as well as the main canals. A station at Vandalia dam, below the last diversion, shows the amount of water not utilized for irrigation from the Milk River drainage basin.

In dividing the water, estimates of daily discharge are ordinarily made at intervals of about one week, but during periods of rapid fluctuation daily computations are necessary. Any discrepancies in the division of the water are thus discovered and corrected in the course of a few days. Tables are prepared showing the inflow and outflow from Sherburne Lake, the natural flow of the rivers, the amount to which each country is entitled, and the water received by each. If either is receiving less than its share under the treaty the headgates of the canals or the gates at the reservoir are adjusted.

The accompanying table is a sample of the statements supplied to the irrigation officials of Canada. Those for the United States are similar except that the last two columns relate to the United States.

DIVISION OF ST. MARY RIVER WATER BETWEEN CANADA AND THE UNITED STATES, AUGUST 3-7, 1919
(Quantities in Second-Feet)

Date	Diverted by U. S. R. S. Canal	St. Mary River at Boundary	Total	Stored Water Released	Naurtal Flow St. Mary River at Kimball	Canada's Share	Canada's Excess (+) or Deficiency (—)
3	389	470	859	203	656	492	—22
4	389	480	869	198	671	500	—20
5	386	475	861	233	628	471	+ 4
6	385	470	855	259	596	447	+23
7	385	457	842	257	585	439	+18

The first column shows the water diverted by the United States, the second that received by Canada; the sum is the amount of water in the river. From this is subtracted the stored water released, to give the natural flow of the river, from which is determined the share of each country.

As a rule the quantity of water flowing at any station is determined from the gage-height records of water-stage recorders by means of a station rating table, which is kept up to date by frequent current meter measurements. The field work of dividing the water has been carried on now for practically three years without misunderstanding or disagreement, with no complaint from either side, and although the division must continue as long as the water of the two rivers is used for irrigation the lapse of time should make the possibility of disagreement more and more unlikely.

In the United States, the stream gaging is done by the U. S. Geological Survey in co-operation with the U. S. Reclamation Service. In Canada, it is carried on by the Reclamation Service of Canada. The actual division of water is made by representatives of the Reclamation Service of each country, and the writer acted in that capacity for the U. S. Reclamation Service in 1918 and 1919. The photographs accompanying this article were taken by R. J. Burley, assistant director of the Reclamation Service of Canada.

Insects Destroy More Timber than Do Fires

The average annual loss of yellow pine in Klamath and Lake Counties, Ore., from insects is 150,000,000 board feet, worth $250,000, or 300 times the average annual fire loss. Fully 8 per cent of the yellow pine timber in private ownership has been killed in the past six years, according to the forest entomologist of the Oregon Experiment Station. The principal enemy is the western pine dark brown beetle, which bores through the bark and excavates long, winding galleries in the soft formative tissue next to the bark; the tree is girdled and its sap flow thus cut off. Epidemic infestations occur in cycles of four to five years, when 6 to 8 per cent of the trees may be killed. For eradication both state and federal funds are said to be insufficient.

Bituminous Surfacing for Plank Highway Bridge Floors

Postpones Renewal of Old Bridges by Producing Light, Easily Maintained Floor—Stiff Construction Essential

By M. W. Torkelson
Bridge Engineer, Wisconsin Highway Commission, Madison

In the years 1914 and 1915 the prevailing price for steel bridges erected in Wisconsin was less than 3c. per pound and reinforced-concrete floors cost no more than $10 per cubic yard. Due to the cheapness of new construction many old steel bridges in good condition but provided with wooden floors were scrapped and replaced with new structures, it being felt that it would be cheaper in the long run and more satisfactory to tear out an old bridge and build a new one with concrete floor than to maintain the old floor and bridge. The rise in the price of materials which has taken place since then, beginning slowly in 1916 and continuing rapidly through 1917 and 1918, changed all this. High costs of construction have made it necessary to keep old bridges in service as long as possible.

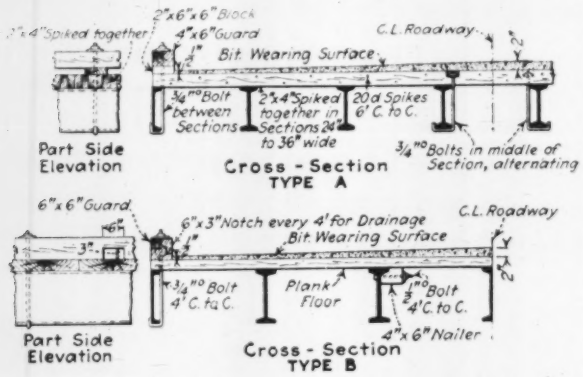
The weak point of the old bridges is the floor, yet they cannot carry the weight of a reinforced-concrete floor and have any live-load capacity left. A light, strong floor which could be maintained otherwise than by replacement was necessary. The Wisconsin Highway Commission first gave this subject consideration in 1917.

At that time Mr. Rollman, then county highway commissioner of Shawano County, at present division engineer for the Wisconsin Highway Commission at Green Bay, began the construction of bituminous-surfaced floors, using laminated units built up from 2 x 4's set on edge, bolted in place and afterward covered with a bituminous surfacing. Several of these were constructed prior to 1917 and are giving satisfactory service. The Illinois highway department had also made experiments along this line, and after correspondence with this department the writer visited several jobs in northern Illinois. Other investigations were made through correspondence. As a result of the information gained from these various sources a memorandum of instructions concerning bituminous floor surfacing was compiled in the spring of 1918 and has since that time served as a basis for installing a number of bituminous wearing surfaces. A standard plan was also prepared for the laminated floor, which is now in frequent use in Wisconsin.

Slightly condensed, this memorandum is reproduced below. It is not contended that the instructions cover the only method of making successful applications. There probably are many others. In fact, experience to date makes it appear that no great skill is required in the construction of bituminous wearing surfaces; that good results are practically certain if a few fundamental requirements are observed:

1. The floor must be tight and the planks must be stiff, so that there is not sufficient deflection to break the wearing coat between adjacent planks.

2. The bitumen should, preferably, be good, heavy material. In one instance where a light tar was used as a seal coat over a heavy tar it appears that the light tar acted as a flux and was responsible for considerable bleeding later on.


2"x4" Spiked together
2"x6"x6" Block
4"x6" Guard
C.L. Roadway
1" Bit. Wearing Surface
¾" ø Bolt between Sections
2"x4" Spiked together in Sections 24" to 36" wide
20d Spikes 6' C. to C.
Part Side Elevation
Cross - Section TYPE A
¾" ø Bolts in middle of Section, alternating
6"x6" Guard
6"x3" Notch every 4' for Drainage
Bit. Wearing Surface
C.L. Roadway
¾" ø Bolt 4' C. to C.
Plank Floor
1" ø Bolt 4' C. to C.
4"x6" Nailer
Part Side Elevation
Cross - Section TYPE B

BITUMINOUS SURFACING ON LAMINATED AND PLANK FLOORS, WISCONSIN STANDARD

3. The bitumen should be applied in light coats and plenty of absorbent used. Experience will soon indicate just how each should be applied, but the beginner will do well to use about twice as much absorbent as he thinks the bitumen can possibly fill. It will be well to have a supply on hand for future applications in case there should be bleeding.

Bituminous Protection for Plank Bridge Floors (Abstract)

4. The application must be made on a clean, dry surface.

It is possible to protect plank bridge floors very effectively by means of bituminous carpets, using either tars or asphalts as the bituminous ingredient.

In using such treatment it is important that the bridge shall be as free from vibration as possible. To this end all bridges should be carefully examined to make sure that the bridge is resting firmly on its bearings. If necessary, the bearings should be shimmed up to make each take its proper load.

No one factor is of as great importance in securing success as having the plank floor tight. The failures that were observed resulted in part from an improper mixture of the ingredients of the coating, but if the floor is not tight it makes no difference how good the ingredients may be, traffic will force the bitumen through the cracks, holes will develop and the protective coating will be lost.

If new planking is to be supplied the planks should by all means be creosoted, as in this way they will be protected against rot as well as wear. The Illinois State Highway Department, which has had considerable experience, recommends that the plank be matched (shiplapped). Good results can be secured, however, with ordinary planks. The planks should in any case be drawn as tight together as possible and well spiked in place. Cracks between planks which cannot be filled in any other way should be calked with jute or oakum. It would also be well in case new planks are to be supplied to buy these of commercial 4-in. thickness; commercial 3-in. planks are usually about 2⅝ in. actual thickness, which is too thin for present-day loads.

Where the bituminous covering is to be applied to plank floors already on the bridge it is necessary to go to much more trouble to stop the cracks. In case the planks are rather far apart, as much as ¼ in., it will probably be best to pull the spikes and re-lay the planks. Possibly a little dressing of the edges of the planks might be helpful. If the number of wide cracks is not too great it probably will be economical to fill these with wooden wedges, using lath or thin lumber from packing cases which will fit snugly and can be driven between the planks, cut off flush with their tops, and toe-nailed in place so that by no possibility can they be forced through. Small cracks should be caulked with jute or oakum.

Previous to the application of the bitumen care should be taken to make sure that the planks are clean and dry. This result can be secured either by sweeping with a good stiff broom or by scrubbing with water. If it is possible to use water under pressure this is the best method. Probably a combination of the washing and the sweeping will be most effective. In any case the essential thing is to have all dust, dirt or vegetable matter absent, as these will prevent the proper adhesion of the bitumen to the planks. A sufficient time should elapse after washing to insure that all moisture remaining is thoroughly dried out.

Either tars or asphalts can be used as the bituminous ingredient of the coating. The bitumen should be a good heavy product, Tarvia A or Tarvia X, Trinidad A or even heavier asphalts. Where the treatment is to be given to an uncreosoted plank floor the first application of the bitumen should preferably be a very thin coat of light tar which can be applied without heating, such as Tarvia B, which should be allowed to dry before the succeeding applications are made. The heavier bitumens should then be applied, using ⅓ to ½ gal. per square yard.

The temperature necessary to produce proper results will vary with the bitumen. Tarvia A should be applied at a temperature of about 225 deg. F. Trinidad A can often be applied in warm weather without additional heating. Some of the heavier asphalts, on the other hand, will require to be heated to a temperature as high as 350 deg. The proper temperature is that at which the bitumen will flow with reasonable freedom and remain fluid for a sufficient length of time to permit the proper incorporation of the absorbent.

The application of the absorbent should follow the application of the bitumen very closely. The best absorbent consists of screened gravel or stone chips not smaller than ¼ in. nor larger than ¾ in. The absorbent should be spread carefully over the bitumen with a square-pointed shovel to such a thickness as will just absorb the bitumen applied. As soon as sufficient of the absorbent has been applied to make it practicable the absorbent should be worked into the bitumen by means of a power roller if this is available, or if not by means of tampers. When thoroughly cooled make the next application in the same way.

The finished covering should vary in thickness from 1½ in. to 2 in. at the center of the bridge to ½ in. at the edges. This is sufficient for drainage. The Illinois Highway Commission recommends crowning the planks, but the utility of this appears doubtful when it is considered that no water can come in contact with the planks. A sufficient number of coats should be applied to bring the coating to required thickness, narrowing the applications to produce the crown effect referred to. Each application should be thoroughly cool before the next is made. Travel between applications is not harmful provided the bitumen has cooled off and the surface is thoroughly cleaned before the next application is made.

It is equally practicable to use bituminous coatings on concrete floors. Where the bridge is located on a highway which is treated with a bituminous covering it is practicable to continue the bituminous treatment across the bridge.

Panama Tolls Reach Million a Month

September tolls earned by the Panama Canal were $1,010,166.33, an increase of nearly $74,000 over the August record, although the number of vessels and craft decreased from 301 to 274. The net tonnage of the 256 commercial vessels, according to the *Panama Canal Record*, was 1,008,785 tons, 57,440 tons greater than for August. During the fiscal year ending June 30 ordinary expenses, exclusive of depreciation or interest, for the operation and maintenance of the canal including those of civil government and sanitation were $6,548,272.43. Tolls and other receipts for the same period were $8,935,871.57. Since 1914 the total excess of expenses over revenue for operating the Panama Canal has been $2,231,091.61.

Borrowing Power and a Fair Return For Public Utilities

By William G. Raymond
Dean, College of Applied Science, State University of Iowa, Iowa City

THAT THE fair return on investment in utility properties properly regulated is from one and one-third times the going rate for money loaned such utilities with proper security to one and a half times that rate is the conclusion drawn from the following analysis of lenders' and borrowers' demand. When one loans money on about the best security that any one knows of, namely an Iowa farm mortgage, he intends to loan not more than half of the value of the property mortgaged. When one loans money to an industrial enterprise he proceeds on much the same basis. Looking first to the earnings he lends only so much as shall require an interest payment equivalent to half the reasonably certain net earnings of the enterprise. As in the case of the farm mortgage, the lender requires a value to be shown by earnings capitalized at his demanded interest rate equivalent to twice the sum that he is willing to lend.

Money lent to industrial enterprises is less well secured than is that lent on farm mortgages, and hence although a value of twice the mortgage loan may be ordinary and ample security for a farm loan, twice the value of a mortgage loan in the case of an industrial enterprise is about the irreducible minimum because of the greater risk of the money invested in an industrial enterprise. Usually somewhat more than a reasonably certain earning capacity of twice the interest charge must be shown to secure loans at the ordinary market rate for money.

The investor who loans to an industrial enterprise by the purchase of stock, runs greater risk of loss than he who loans on a mortgage, that is to say, than he who buys the bonds of the enterprise; and it would seem to be reasonable to conclude that he who invests his money in the stock of the enterprise should expect a reasonably certain net earning capacity to be shown, over and above the payment of operating expense and the fixed charges, of at least twice the lending rate on the money that he invests, and almost as reasonable to conclude that a prospect of three or more times the lending rate on the money which he invests is necessary to induce the investment. The net earnings need not be all distributed as dividends—the accumulation of a surplus is a business necessity even with a utility enterprise.

Utilities Not Free From Risk Element

Money invested in a public utility is supposed to be somewhat less hazardously invested than that invested in other entirely independent, free from control, enterprises. In theory this is probably true, albeit in practice it often proves to be untrue. The public, in spite of its oft time carelessly and sometimes wilfully unfair demands on its utilities, believes that because of their monopolistic or somewhat monopolistic character they are less risky enterprises than other independent, free from control, undertakings, and hence should demand a less rate of return on the investment. Probably it would be quite difficult to disabuse the public mind of this attitude, because theoretically the attitude is right and practically it would be right if the public was always fair.

Based on these suggestions that the lender to industrial enterprises expects a reasonably certain net earning capacity of not less than twice the interest charge on the total indebtedness, and usually expects more than this; that the other investor must expect not less than the lender and should probably expect more after paying the lender his interest, and that a public utility investment should be somewhat more secure, even though it is not always so, than an independent, uncontrolled enterprise, the following discussion of fair return on capital invested in a public utility is developed.

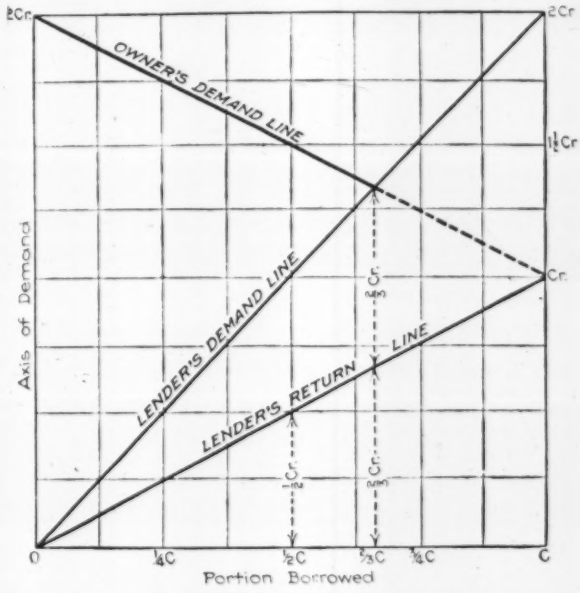


FIG. 1. EARNING CAPACITY TWICE FIXED INTEREST CHARGE REQUIRED BY LENDER

Problem 1. Let be assumed that the lender requires the minimum net earning capacity of twice the fixed charge, and that the owner investor requires this same minimum on the sum that he invests, and let "C" represent the total capital investment in an enterprise and "r" the lender's normal rate of interest. Then, referring to Fig. 1, if none of the money is borrowed the earnings to satisfy the lender investor should be nothing.

If all of the capital is borrowed the annual net earnings to satisfy the lender will be 2Cr. If axes of "portion borrowed" and "demand" are drawn, and a line is drawn from the intersection of the axes to a point 2Cr above C on the axis of "portion borrowed," an ordinate to this line from any point on the axis of "portion borrowed"—as ½C—will be to scale the net annual earning demanded by the lender. So far as the lender is concerned these ordinates measure the total required net annual earnings. The line drawn is called the lender's demand line. A line drawn from the intersection of the axes to a point Cr above C on the axis of portion borrowed may be called the lender's return line since ordinates to this line measure the annual interest payments to the lender—the fixed charges.

If the matter is considered from the standpoint of the owners demand for return and risk—an ordinate of 2Cr erected at the intersection of the axes will measure the demand when nothing is borrowed, and since the owner has nothing invested when all the capital is borrowed, his demand for this condition is only the fixed charge. Hence if a line be drawn from the point 2Cr above the intersection toward the point Cr above C, until it intersects the lenders demand line at Q, the ordinates

to this line will measure the owner's total demand on account of return and risk. The portion of these ordinates below the lenders return line measure the fixed charges, and the portion between the lender's return line and the line last drawn, called the owner's demand line, will measure the earnings on account of return and risk demanded by the owner on account of his own investment.

Up to the point of intersection Q, it is the owner's demand that determines total required earnings on account of return and risk. Beyond Q, it is the lender's demand that determines these earnings, since the owner's demand is less than the lender's demand when the portion of capital borrowed is more than that shown directly below Q on the axis of portion borrowed. Beyond this point the owner will receive more than his demand.

It can be shown by measurement on the diagram and by mathematical analysis that under the conditions of the problem the point Q is directly over the point $\frac{2}{3}$C on the axis of portion borrowed. The conditions of the problem are:

1. The lender demands total net earnings equivalent to at least twice his interest charge.
2. The owner demands total net earnings of twice the lender's rate on the money invested by himself.
3. Net earnings means, to the lender, earnings over and above operating expenses, and to the owner, earnings over and above operating expenses and fixed charges.

The diagram shows that under the conditions of the problem when less or more than two-thirds of the capital is borrowed the total earnings on account of return and risk must be greater than when just two-thirds of the capital is borrowed, the owners demand determining these earnings when less than two-thirds is borrowed and the lender's demand determining when more than two-thirds is borrowed.

Stated in another way, the total fair earnings on account of return and risk are a minimum when two-thirds of the invested capital is borrowed. At this minimum point the total fair earnings on account of return and risk are $\frac{4}{3}$Cr or once and one-third times the lender's interest rate on the whole investment. Of this sum $\frac{2}{3}$Cr goes to the lender and $\frac{2}{3}$Cr to the owner. The lender receives his regular rate of r per cent, on his loan and is secured by net earnings equivalent to twice this sum. The owner receives twice the lender's rate on his own contribution to the investment, and this covers fair return on a safe investment and payment for his risk.

From the standpoint of a public controlling utility enterprise and wishing to be fair it seems to be desirable that just two-thirds of the capital invested in these enterprises shall be borrowed, because with this proprotion borrowed the net earnings required for interest and fair dividends is a minimum. Indeed it may be reasoned that in determining a fair return rate it should be assumed that the utility has adopted this borrowing limit; that if it has borrowed less it should be satisfied with a less return; and that if it has been able to borrow more it is entitled to the extra return resulting.

If this assumption is made, then under the conditions of this problem the fair rate of return on the total investment—not on cost of reproduction—should be one

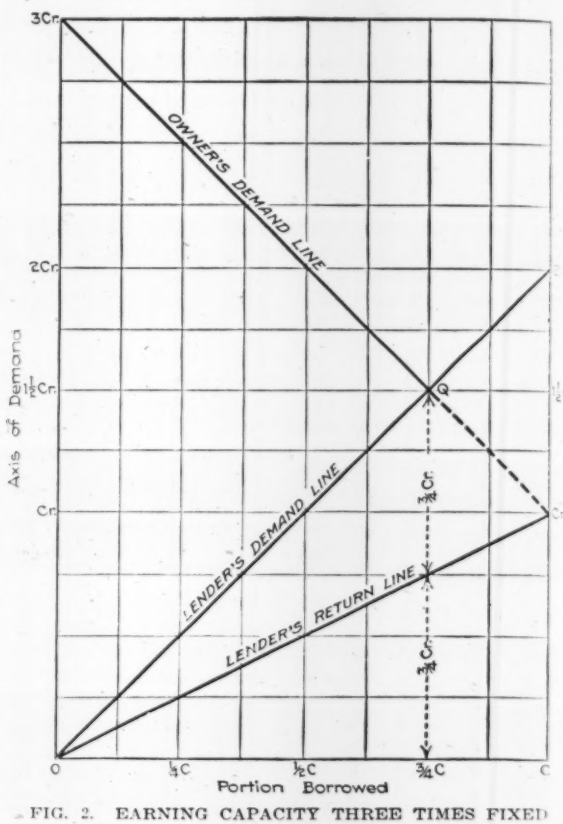


FIG. 2. EARNING CAPACITY THREE TIMES FIXED INTEREST CHARGE REQUIRED BY LENDER

and one-third times the going rate of interest, including the effect of discount, paid by utilities of the kind under consideration at a particular time. Thus, if 6 per cent is the going lender's rate, 8 per cent would be the fair rate of return on the investment. This would pay the lender 6 per cent on his contribution to the capital, and give him ample security, and would pay the owner 12 per cent for his fair return and risk. It is believed that such returns will attract capital to utility investment, and that less than such returns will be not attractive.

As possible allowable variations from the financing plan most favorable to the public, it may be assumed that as little as one-half of the investment is borrowed or as much as three-fourths of the investment is borrowed.

Referring to the figure or to a computation it will be found that if one-half the investment is borrowed, the total earnings on account of return and risk are 1½Cr. The lender receives r per cent on his contribution and the owner 2r per cent on his contribution as before. If, however, one-half of the capital has been borrowed and the enterprise is allowed earnings on account of return and risk of only one and one-third times the lender's rate, then the owner will receive not 2r per cent on his contribution, but 1⅔r per cent.

If three-fourths of the capital is borrowed it is found, by reference to the figure or to a computation, that once and one-half times Cr is required on account of return and risk, just as when one-half of the capital is borrowed As in that case too, the lender will receive r per cent on his contribution, but the owner will receive 3r per cent on his contribution. If, however, the

regulating body limits earnings to those suitable when two-thirds of the capital is borrowed, the owner will receive 2½r per cent.

Problem 2. Let it be assumed that the lender requires an earning capacity equivalent to twice the fixed charge and that the owner investor requires on his investment a net earning capacity, over and above fixed charges, of three times the lender's rate. Then referring to Fig. 2, it is seen that if none of the money is borrowed the total net earnings should be 3Cr. If all of the money is borrowed the total net earnings should be 2Cr. If ¾ of the money is borrowed the lender's requirement and the owner's requirement are the same, namely ¾Cr, and as before, if less than ¾ is borrowed, required earnings are determined by the owner investor's demand, and if more than ¾ is borrowed the earnings are determined by the lender's demand.

Under this problem the most economical arrangement for the public is that the company shall borrow ¾ of its necessary investment, and the fair rate of return on the total investment is ¾ of the lender's rate; that is, if the company can borrow money at 6 per cent the fair rate of return is 9 per cent.

Again if only half of the capital is borrowed, the lender will receive his rate of r on his contribution, and the owner will receive a rate of 3r on his investment. If, however, the earnings on account of return and risk are limited to ¾Cr—or those suitable when three-fourths of the capital is borrowed—the owner will receive only 2r instead of 3r.

It is suggested that Problems 1 and 2 include the limitations of proper public utility earnings under that conception of public control that demands that the earning rate shall be limited to a fair rate of return on the fair value of the property used in the service of the public. To be sure nothing has been said about value. Only investment has been considered. But it is thought that a method has been developed for finding the fair rate of return on investment—that rate which is the least that will attract capital to enterprise, and it is believed that this rate on investment will result in a fair rate of return on value. The rate which may be selected by the application of this method may be applied to original cost to date, or to reproduction cost—whichever may seem to a court to be the proper measure of investment—or as is commonly said, value.

Relation to Fair Value

In the opinion of the writer the method should be applied to original cost to date as nearly as that can be determined, and such application will result in a fair return on the fair value of any property that may be under consideration.

The discussion would seem to result in the conclusion that the fair rate of return on investment in utility properties properly regulated is from once and one-third the going rate for money loaned to such utilities with proper security, to once and one-half times that rate, the lower rate applying to large, old, seasoned, substantial enterprises, in the older communities, with accumulated and maintained emergency surpluses, and the higher rate applying to smaller, newer, less well seasoned enterprises, in new or old communities.

The discussion also suggests some interesting questions with respect to the proper or advisable relative proportions of bonds and stock to be issued when financing utility enterprises.

Factors Influencing Ultra Violet Light Water Treatment

By Russell D. Scott
Chief Chemist, Ohio Department of Health

THROUGH the courtesy of the R. U. V. Co., New York City, the Ohio Department of Health was enabled to conduct some tests on water sterilization by ultra violet light. A single-bulb type of machine, this company's "P S," rated at 120 gal. per hour was used, the influent being supplied from a tank holding 90 gal.

TABLE I. EFFECT OF ULTRA VIOLET RAY TREATMENT OF SEWAGE-DOSED WATER

Rate of Flow Past Lamp, Gal. per Hr.	Per Cent Sewage in Influent	Turbidity of Influent, P.P.M.	Bacteria per Cu.Cm. 37 Deg., 24 Hr. Influent	Bacteria per Cu.Cm. 37 Deg., 24 Hr. Effluent	B. Coli-Presumptive Smallest Volume Positive, Cu.Cm. Influent	B. Coli-Presumptive Smallest Volume Positive, Cu.Cm. Effluent
175	0.1	0.1	170	12	0.01	1
1.5	0.1	0.1	170	1	0.01	1
95	0.1	0.1	170	0	0.01	10
75	0.1	0.1	170	0	0.01	100
64	0.1	0.1	170	0	0.01	Neg. 100
104	1	1	750	5	0.001	1
79	1	1	750	0	0.001	1
61	1	1	750	1	0.001	10
46	1	1	750	0	0.001	Neg. 10
129	2	2	2,200	95	0.001	0.1
65	2	2	2,200	8	0.001	1
47	2	2	2,200	1	0.001	Neg. 10
54	10	10	7,350	25	0.001	0.1
32	10	10	7,350	5	0.001	10
18	10	10	7,350	0	0.001	10
7	10	10	7,350	1	0.001	Neg. 10

Preliminary tests having indicated that an initial period of at least 15 minutes was required for the lamp to reach an efficient working temperature, no samples were collected until it had been burning for at least 30 minutes.

The first runs were made using as influent Columbus tap water to which had been added fresh, cotton-filtered sewage in percentages as shown in Table I. The results indicate the sterilization of a heavily polluted water at the rate of about 50 gal. per hour with a turbidity of 2. With the influent containing sewage sufficient to produce a turbidity of 10 p.p.m. the effective rate was greatly lowered.

TABLE II. EFFECT OF TURBIDITY ON ULTRA VIOLET RAY TREATMENT

Rate of Flow Past Lamp, Gal. per Hr.	Turbidity of Influent P.P.M.	Typhoid Bacilli per Cu.Cm. Influent	Typhoid Bacilli per Cu.Cm. Effluent
175	0	31,000	150
93	0	31,000	15
64	0	31,000	4
180	12	27,000	300
90	12	27,000	50
65	12	27,000	32
175	66	22,000	500
93	66	22,000	180
66	66	22,000	130

To more definitely note the effect of turbidity some runs were made using as influent tap water to which was added 0.02 per cent of a broth culture of typhoid bacilli, followed by graded amounts of a sterile, finely divided clay soil in suspension. The results (Table II) show a progressive decrease in efficiency of sterilization with increasing turbidity.

The effect of color was next studied, the influent consisting of tap water plus 0.1 per cent of sewage and varying quantities of a filtered decoction of black tea leaves. The effect of color (Table III) is evidently pronounced. While by present methods of coagulation

and filtration it is possible to remove practically all turbidity from a water, the removal of color is not in all cases so successful. This fact should be taken account of in considering the U. V. treatment as an adjunct to filtration.

In conclusion it should be noted that the results obtained were from small-scale operation, the actual efficiency of the U. V. process in large-scale operation being much higher.

TABLE III EFFECT OF COLOR ON ULTRA VIOLET RAY TREATMENT

Rate of Flow Past Lamp, Gal. per Hr.	Color, Influent	Bacteria per Cu Cm. 37 Deg., 24 Hr. Influent	Effluent	B. Coli-Presumptive Smallest Volume Positive, Influent	Cu Cm. Effluent
72	1	92	0	0.01	10
49	1	92	0	0.01	Neg 10
70	18	92	2	0.01	1
48	18	92	1	0.01	1
30	18	92	1	0.01	10
68	25	93	5	0.01	1
49	25	93	2	0.01	1
30	25	93	0	0.01	10
75	90	98	38	0.1	1
52	90	98	27	0.1	1
34	50	98	26	0.1	1

Henderson, Ky., results (*Engineering News-Record*, Nov. 29, 1917, p. 1021, article by A. T. Smith) indicate that rates of 200,000 gal. daily per lamp are used, each effluent stream passing under five lamps in series. A progressive reduction in bacterial content is noted at each lamp, the final effluent being practically sterile. However, the results of the present paper emphasize the importance of thorough preliminary treatment to remove turbidity and color, before employing the ultra violet process.

Earthwork Methods on an English Railway

Exceptional care in the building of large railway embankments, in order to prevent slipping of the slopes, has been employed in the construction of a double-track relief line for the Great Northern Ry. of England. These fills, according to the *Railway Engineer*, London, were to be made with London clay, and after examination of a number of old banks made with this material a cross section was adopted with compound or graduated slopes conforming to the final sections to which the older banks have settled. Thus in a 10-ft. bank the slope from the roadbed is 1 on 2, with a base width for each slope of 20 ft.; for a 20-ft. bank this is followed by 1 on 3 for 30 ft. base; a 30-ft. bank has an additional slope of 1 on 3½ for 35 ft.; a 40-ft. bank has still a fourth slope of 1 on 4 for 40 ft., and a 50-ft. bank has this 1 on 4 bottom section continued over a base of 80 ft., making a total width of 165 ft. for each slope of a 50-ft. fill. These fills have a top width of 45 ft.

All material was side dumped and built up in 10-ft. lifts, wooden templates being used by the contractors in dressing the fill to the required section. The slopes were then covered with good soil and sown with grass. The work was done a few years ago and it is stated that there are no signs of slipping.

A cut in loose running sand caused some trouble and this material had to be wasted in spoil banks as it could not be used for fills. At times the steam shovels were overwhelmed by the sand. The very wide cut formed was not left in its rough condition, the excess excavation being filled with hard material and finished to the standard section with lump slag and old broken concrete.

Metal Flume Inspection on the Uncompahgre Project

Life of Metal Prolonged by Coal-Tar Paint—Rusting Mainly at Joints—Cement Patches Used—Ice Kinks Bottoms

RESULTS of the inspection in 1920 of 69 metal flumes on the Uncompahgre Project of the U. S. Reclamation Service indicate that careful attention should be paid to the following points if a life of ten years is to be obtained:

(1) Proper design as to sufficiency of foundation, sizes of bands, washers and cross ties, and a thickness of metal which will obviate excessive deformation; (2) thorough galvanizing; (3) joints which do not project into the current and which avoid cavitating; (4) trapping out of sand and gravel; (5) coating with a good quality of coal tar of joints and of inside of sheets as frequently as wear makes necessary, possibly joints every year and inside surface every two, three or four years; (6) provision for temperature changes either in the individual joints themselves or by expansion joints; (7) provision for self-drainage.

F. D. Pyle, formerly project manager of the Uncompahgre Project, now secretary and manager Columbia Irrigation District, gave these results in the November *Reclamation Record* from which the following notes are taken:

Substructures — All substructures were of wood. Some were untreated, some treated by dipping in creosote oil and some were painted. The substructures that were painted appear to be in the best condition. The untreated lumber was weathered and checked considerably, and the treated lumber showed some deterioration but not as much as the untreated. In a few instances dry rot was apparent in isolated pieces of timber.

In a considerable number of instances where dirt and alkali soil, especially sand or sandy loam, had been allowed to come in contact with the bottom of the substructure posts and braces, rot has made it necessary to cut off and block under the posts and to replace braces in from five to ten years.

A considerable number of crossties were cracked, and gave the general appearance of being too small for the load carried. On a number of the flumes the washers were pulled into the crossties, where the flumes had been tightened to prevent leaks several years afterward. This indicates that the crossties and washers were both too small and on account of the number of flumes affected it is believed that our designs have not provided adequate sizes to give the best results.

Paint—Of the 69 flumes, 59 have received a coat of tar or paint on the interior in order to protect them against rust and erosion. The first tar was used in 1913 but proved to be too brittle and lifeless. In the spring of 1916 various kinds of paint were tried without success. Later several paint companies furnished small lots of paint to make tests. In no case have these paints proved equal to the coal tar placed during the past three years.

In the fall of 1917 and spring of 1918 a number of flumes were treated by applying a coat of water gas tar followed by a coat of coal tar thinned with water gas tar. This made considerable extra work, and in a number of cases the coating was too thin, either running to the bottom of the flume or checking and cracking on the side of the flume exposed to the sun. Since the summer of 1918 coal tar has been used without thinning, with very good results. The best results have been obtained when tar was applied before the flume had been used more than one season and when the tar was applied in warm weather. When applied in cold weather it would not stick to the metal but blistered and peeled. In tarring flumes it was found essential to

clean the surfaces thoroughly, removing all rust from the sheets and from the joints, and to have them perfectly dry and free from dust. The tar was applied hot with heavy brushes or burlap swabs.

Conditions indicate that the joints should be retarred every fall, and the entire flume every other fall. On account of the long irrigation season, it has been difficult to tar as large a proportion of flumes each year as would be most advisable. The tar coat fails by drying, checking, peeling and blistering. In some cases there is a tendency to erode from the bottom, especially where gravel is carried by the water. A heavy coating of coal tar has proved to be the best method of protecting the flumes when properly applied. In tarring 502 lin.ft. of No. 204 flume, 550 gal. of tar were used, or 0.58 gal. per sq.yd. The labor and material cost was 21c. per square yard. An extra heavy coat was given this flume.

Flume metal fails principally at or near the joints, although occasionally pitting occurs along the lower joint arc of the flume. Of 930 ft. of flume used eight seasons, 33 per cent pitted through at the joints, and 9 per cent on the surface of the sheets. Pitting generally took place on the downstream side of the joint, with the exception of a few flumes on the West Canal, where the joint was arranged so that there was a flange giving a double thickness of metal below the joint. In this case the pitting was on the upper side of the joint. Where the workmen had inadvertently changed the sheets so that the flange was upstream, the pitting took place on the downstream side of the joint. Apparently all pitting and rusting takes place from the inside or water side of the sheets and works toward the outside. Where the pitting was in the joints it started at the bottom and progressed outward and uward through an arc of 12 to 18 in. Where pitting was along the sheet, it generally occurred at the bottom, although isolated pitting was observed for from 15 to 24 in. from the botttom.

There appears to be a greater tendency for the metal to pit near the black iron fittings of many flumes than where galvanized strips are used as the inside member of the joint, as in the corrugated type.

It is probable that the velocity of water, especially where heavy silt is carried, seriously affects the life of the metal. In one extreme case located below the big drop on the Montrose and Delta canal, where 200 sec.-ft. of water is turned over a sandstone bluff which gradually erodes, the original flume was found badly pitted along the entire length of the flume. However, in another instance a large amount of gravel and sand has been carried through a flume installed in 1914 without serious results, there being no pitting or rusting visible on the outside of the flume.

It is very probable that where alignment is poor, owing to settlement of foundations, additional strain is thrown on the metal, breaking the spelter and hastening rust and pitting.

Alkali water is apparently detrimental to the metal, but no direct cases can be cited.

The life of the metal may be affected by the type of joint. Some joints have sharp bends which cause additional strain on the metal and a tendency to separate the spelter or galvanizing from the metal. In some types of joints where the inside iron projects into the water section, the tendency is to erode the metal below the joint. In other types of flume, the metal is arranged so as to be double or even triple at the joint, giving increased strength and requiring longer for pitting to make the flume leak.

The metal on only a few flumes has been replaced on account of failure of sheets by rusting and pitting. However, in removing the metal on the CQ system in order to increase the capacity, it was found that only about 60 per cent of the sheets could be used for replacement purposes.

Joints—Very little could be learned as to the tightness of the various joints, as leakage depended so much upon whether the flume was being properly maintained and the condition of the tar coating. Apparently all types of joints can be made reasonably tight. In only one instance has a flume failed by pulling apart or giving way at a joint.

Miscellaneous Observations — Several flumes have been badly distorted by ice. Apparently when the ice in a flume commences to melt it starts on the sides and where the water can run off the weight of the ice rests on the bottom portion of the flume so that the metal and the joint rods are permanently distorted or kinked at the bottom.

In several extreme cases the pitting of metal had progressed to such an extent that it was necessary to line the bottom of the flume with cement sacks covered with about 1 in. of concrete. This had proved a good method of obtaining an extra year or two of service from small flumes. In a number of places on these flumes 4 to 10 sq.in. of cement sack is exposed in one patch where the metal is entirely gone.

In tarring the West Canal flumes, which are badly pitted at the joints, about 1 in. of fine gravel and coal tar was placed in the bottom to prolong their life.

Terms of New Cost-Plus Contract for Hetch Hetchy Tunnel Work

TERMS of the contract recently let by the city of San Francisco for 18 miles of tunnel on the Hetch Hetchy project have attracted the attention of other cities where similar conditions obtain, particularly since the legal decision upholds the validity of this form of contract. An announcement of the decision (Supreme Court of California, Crowe vs. Boyle, Oct. 16, 1920) appeared in *Engineering News-Record*, Nov. 11, p. 963.

In response to a request for a résumé of the features involved, the following was supplied by M. M. O'Shaughnessy, city engineer of San Francisco:

The contract embodies construction on the cost-plus plan, with the following modifications:

1. The contractor's fee is a flat sum fixed by competitive bidding and is payable in installments, including three annual advance payments which assist the contractor in financing his work.

2. While the contractor is required to secure and superintend the labor, and is given the right to "hire and fire" men, no change in wage scale can be made without concurrence of both the contractor and the board of public works. Materials and supplies furnished are purchased directly by the city after competitive bidding, in which the contractor himself may participate.

3. The contract contains a guarantee by the contractor as to maximum unit costs of work which were specified by him in his bid. If the actual costs exceed these bid costs, such excess is deducted from the unpaid balance of the contractor's fee. The method of determining the costs is set forth in detail in the specifications.

4. In order to insure the city's receiving the lowest possible bids both for contractor's fee and guaranteed unit costs, the board of public works was permitted to award the contract to the lowest bidder on either basis.

The contract has been in effect about six months, although payment of the contractor's fee had been withheld until the final determination of the suit. The system has worked very satisfactorily so far, and the City of San Francisco anticipated that the total cost will be less, by some $2,000,000, than the lowest flat price bid received under alternative specifications at the same time.

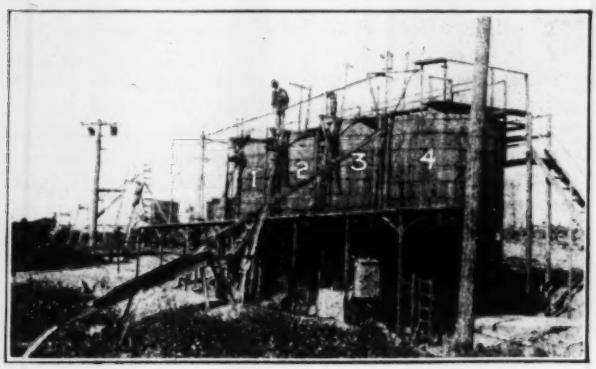
Swiss Railway Projects

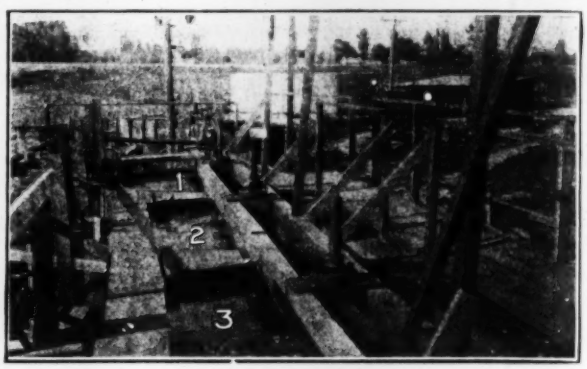
At a recent meeting in Berne, Switzerland, of the board of administration of the Federal railways tne agreements concerning the digging of the new Ulmberg tunnel on the line on the left bank of Lake Zurich and the construction of the foundation walls near Steinen, as well as the electrification of the Sion-Lausanne line, were approved and a credit of 40,000,000 Swiss francs granted for these purposes.—*Commerce Reports.*

Test of Trent Activated-Sludge Devices at Pasadena

By R. V. Orbison
City Engineer, Pasadena, Cal.

During the latter part of the sewage-treatment experiments conducted under the direction of the writer for the City of Pasadena, Cal., tests were made of an activated-sludge plant in which aëration and agitation are effected by pumping sewage and air into the bottom of the activation tank, the distribution being through revolving perforated arms on the Barker mill or revolving lawn sprinkler principle. This is known as the "L. C. Trent aërator for activated-sludge treatment" and the test plant was built from designs made by the L. C. Trent Engineering Co., Los Angeles, Cal. The underlying idea is similar to the Brosius method of aëration and agitation experimented with at Hermosa Beach, Cal., and proposed as a permanent method of sewage treatment for that city, as described by A. M. Brosius in *Engineering News*, Nov. 9, 1916, p. 890. (The bond issue for the proposed plant at Hermosa Beach failed to carry.) The details are different in that Mr. Brosius placed a "diffusion wheel" or impeller type of pump at the foot of a downtake air and sewage pipe within the aërating tank, while Mr. Trent places a centrifugal pump at and outside of the tank base, with a suction extending upward to a horizontal connection with a suction chamber within the tank, and a discharge pipe leading into the distributor at the center of the bottom of the tank. Other differences in detail may be found by referring to the Brosius article. Experience seems to have proved that the aëration effected by both the Brosius and Trent devices was insufficient, so that supplementary air blowers were necessary.





VIEWS OF TRENT ACTIVATED-SLUDGE INSTALLATION, PASADENA, CAL.
Tanks 1, 2 and 3 are for aërating the sewage, and Tank 4 for settling the sludge. It was found necessary to pump the sludge from Tank 4 to a sludge re-aërating tank.

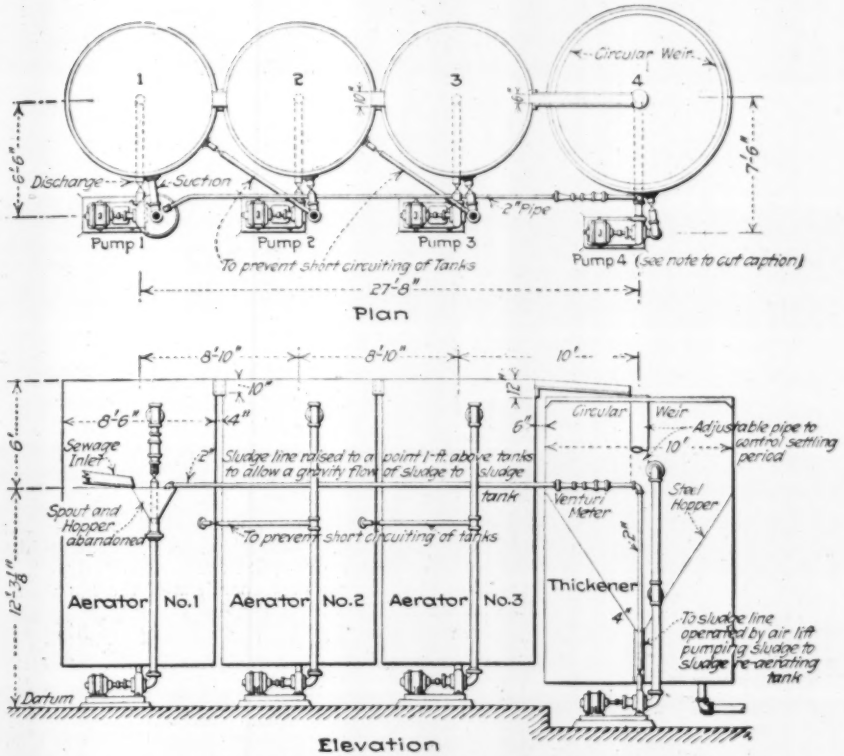
In the Trent experimental plant as originally designed the process was all comprised in three sewage aërating tanks and a final sludge aërating and settling tank. As explained below, the writer found it necessary to force the settled sludge to a re-aëration tank.

The Trent plant was operated from Jan. 1 to July 15, 1919, when the experiments with activated-sludge, which had begun in 1917 at an earlier plant, were discontinued. Had more money been available the Trent ideas would have been continued, with some changes in detail to increase the mechanical agitation and an attempt to find a pump that would handle more air without becoming air locked. As matters stood when the test stopped, the general conclusion as to the Trent variation of the activated-sludge process was that it required the use of an air blower and a sludge re-aërating tank with filtros plates, and that the results obtained were not nearly as satisfactory as with the old plant. The process was too erratic; was not dependable, as is indicated by the stability curve, and required too close attention, especially as compared with the old plant.

As first operated, the Trent plant consisted of three cylindrical aërating tanks 8 ft. in diameter, and a settling and thickening tank 10 ft. in diameter, all four tanks having an effective depth of 15¾ ft. Each tank was supplied with a centrifugal pump having a capacity of 220 gal. a minute, directly connected to a 3-hp motor, and with revolving air distributers, but as it was found impossible to aërate, thicken and settle sludge in one and the same tank, the machinery was removed from the fourth tank and it was used for settling only, by installing a steel cone, 10 ft. in diameter at the top, 4 ft. in diameter at the bottom, and 10 ft. deep, an air lift being used to force the sludge from the settling tank to the sludge re-aërating tank of the old experimental activated-sludge plant.

The aëration and agitation pump of each of the three activation tanks drew sewage through an outside suction pipe from a point in the side of the tank about 2½ ft. from the top. The pumps discharged through nozzle arms near the bottom of the tanks, there being three arms in each tank and each arm having attached to it two 1¼-in. nozzles, spaced so as to cut different paths on the bottom of the tanks, thus preventing deposition of sediment.

At the start it was assumed that sufficient air for oxidation would be drawn down the sewage suction pipe through a number of ¾-in. pipes extending above the top of the suction pipe. The plan worked in principle but the air thus supplied was insufficient. Consequently we tapped into each pump discharge pipe a ½-in. air pipe connected with a blower, but with the conditions under which the blower was operating it was impossible to force the air into the tanks, and in order to accomplish this, one filtros plate was installed in each of the three aërating tanks. This produced better results within 48 hours.



OUTLINE PLAN AND SECTION OF ACTIVATION AND SETTLING TANKS AS ORIGINALLY BUILT

After trial the following changes were made: (1) The hopper shown in Tank 1 was abandoned and the sewage piped to a Y, connecting with a second pump at the base of Tank 1, pump 4 being moved to this point and delivering the raw sewage to the top of Tank 1. The top of Tank 1 is 5 ft. above the outlet sewer and pump 1 was air-locked too often for satisfactory results. (2) A Nash hydro-turbine air blower was set in the place occupied by pump 4, for reasons stated in the text. (3) The horizontal run of sludge pipe was raised to a level 1 ft. above top of tanks to allow a gravity flow to the sludge settling tank.

The raw sewage enters the first tank at the top. In starting the process, the first tank was filled to the level of the suction pipe, after which the corresponding pump was started, forcing the sewage through the nozzles and making the arm revolve. When the tank was full its contents would overflow into the second tank, where the process was repeated, and thence to and through the third tank in the same manner and on into the settling tank where sedimentation for some 45 minutes took place. To prevent short circuiting, baffles were provided at the connections between the various tanks.

The aërated sewage entered the settling tank through a central pipe 24 in. in diameter and 3½ ft. long, telescoping over which was another 3½-ft. length of pipe which could be so raised or lowered as to give settling periods of various lengths. The discharge (the effluent) was over a circular weir 9½ ft. in diameter, concentric with the tank, which was 10 ft. in diameter.

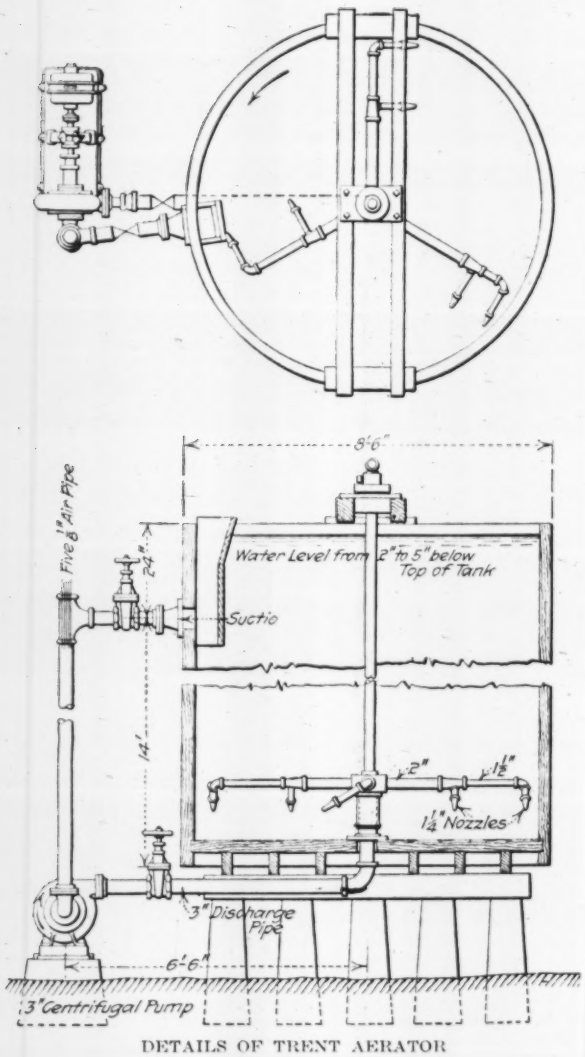
Until ready to use the sludge re-aërating tank the sludge was pumped from the settling tank back into the first activation tank, from which it passed on through the other two and back into the settling tank. When sufficient sludge had accumulated in the three aëration or activation tanks then we began forcing the sludge to the re-aëration tank, as already mentioned. This tank was 5 ft. 9½ in. x 12 ft. 4 in. in plan, had an effective depth of 9 ft. 6 in., and was provided with four filtros plates for air diffusion. After from 2 to 4 hours of aëration the sludge was run into the raw sewage pipe and sent back to the first activation tank. When sufficient activated sludge had been accumulated in the sewage aëration tanks, the excess sludge, beyond what was needed for renewal purposes, was wasted over a control weir which could be set to return any desired percentage of the sludge.

It was thought by the Trent people that the settling tank could be used for settling, thickening and re-aërating the sludge by drawing in air through a 3-in. centrifugal pump and aërating and agitating the sludge by revolving nozzle-arms. This was found impracticable — at least the pump could not provide sufficient air for the volume of sludge that it handled — and so the nozzle-arms were removed.

Before adding the blower to increase the air supply above that afforded by the centrifugal pump and free-air-supply pipes the effluent had a turbidity of 30 to 50 p.p.m. and an average of 50 p.p.m., and an albuminoid ammonia reduction equal to that given by the old activated-sludge test plant (70 to 80 per cent) but with a dissolved oxygen ranging from 0.5 to 4 p.p.m., as compared with nothing to a trace by the old plant. Also our sludge volume after a five-day run was equal to 12 per cent on settling 30 minutes, compared with 6 per cent from the old plant, but with a stability generally ranging from 3½ to 23 hours and once in a while extending to 3, 5 and even 10 days, whereas after the old plant had been running a week it gave a stability of 10 days plus throughout the whole 18 months' test. The bacterial count in the old plant was from 13,000 to 450,000, averaging 143,500, as compared with 200,000 to 2,000,000 for the Trent plant. We also found, before adding the blower, that by filtering through filter paper a sample of the effluent from the third activation tank we got a stability of 10 days, against an average of about 8 to 10 hours without filtration. The raw sewage, filtered, has a stability of about 10 hours and unfiltered of about a half hour. The added air from the blower soon increased the stability to 18 hours and also yielded nitrifying bacteria, which we lacked before.

The Trent tanks were built of the sizes already stated with the desire of giving a capacity of 50,000 gal. with 4 hours of aëration, the same as in our earlier experimental plant. We found that with only 4 hours' aëration the sewage became septic and had to increase the period to 8 hours.

In order to determine what would be needed to meet our requirements, further experiments would have to be made with Trent process, along the lines of supply-



DETAILS OF TRENT AERATOR

ing additional air, the use of different pumps, and the installation of machinery to reduce the cost of operation. While the Trent process made a very creditable showing and compared very favorably with the activated-sludge process, yet it took twice the time, and cost more to operate.

Result of Stopping Chlorination One Day

The town of Pittsburg, Cal., takes its water supply from the Sacramento River and treats it with chlorine. As the population served is only about 5,000, a single small-capacity chlorination plant was considered sufficient. Recently, according to a paper presented by Ralph Hilscher, director of the Engineering Division of the California State Board of Health, before the California Section, American Water Works Association, the chlorine apparatus had to be taken out of service for repairs. For the short time during which chlorination was to be discontinued it was not considered necessary to start up the chloride of lime plant, provided for emergency use, and hence raw water was supplied for one day. As a result, 100 cases of typhoid developed besides a considerable number of cases of other water borne diseases. In view of this experience Mr. Hilscher recommended the installation of duplicate chlorination plants so that one might always be held in reserve.

General Contractors Recommend Rental Schedule

Guide to Estimating Construction Equipment Expense Prepared by A.G. C. Committee on Methods

WITH a view to furnishing contractors with a practical means of estimating equipment expense and determining adequate rental charges the committee on methods of the Associated General Contractors of America has worked out a standard rental schedule for the association. The schedule has been evolved from the records and experiences of contractors, manufacturers and rebuilders of equipment and has been prepared by the research division under the direction of the committee on methods. The schedule, explained in the following paragraphs taken from a recent issue of the association's *Bulletin*, has been approved by the executive board of the association.

Seven items of equiment expense constitute the total rental charge and require consideration in estimating a lump sum contract or in determining fixed rate rentals. The items referred to and their annual proportions of the equipment's initial cost are as follows:

	Item	Per Cent
1.	Average depreciation	12½
2.	Equivalent annual interest at 6½ per cent	4
3.	Shop repairs	6
4.	Field repairs	4
5.	Storage and incidentals	3½
6.	Insurance	1
7.	Taxes	1
	Total annual expense	32
	Equivalent expense on basis of eight months' working time per year	48
	Rental rate per month	4

How Percentages Were Obtained

These percentages and those given in the detailed schedule were determined according to the following principles:

The economical life of a machine is considered to end when its value has depreciated to 25 per cent of the original cost. The average annual depreciation then amounts to 75 per cent of the initial cost divided by the number of years it may be expected to give service. The initial cost of a machine is represented by the cost of that machine delivered at the contractor's yard.

Interest should naturally be charged at the prevailing rate. This may be computed in three ways:

(1) By charging the prevailing rate each year on the depreciated value of the machine.

(2) By charging the prevailing rate each year on the average value of the machine during economical life. For example, when the salvage rate value is 25 per cent the average value equals (100 per cent + 25 per cent) divided by two, equals 62½ per cent.

(3) By finding the proportion which the average value is of the initial cost and charging this proportion of the prevailing rate each year. This proportion is called the equivalent annual interest and shows what interest rate on original cost will yield the same interest as the prevailing rate when applied to the depreciating value of the machine. This is the method used in the above schedule. The average value is 62½ per cent of the original; therefore the equivalent annual rate is 62½ per cent of the prevailing rate, or 62½ per cent of 6½ per cent equals 4 per cent.

Shop and field repairs are separated by reason of a previous recommendation of the committee on meth-

ods that field repairs be considered a part of the cost under cost plus contracts and shop repairs be borne by the contractor and covered by the fixed rate rental charge. This recommendation was made on the ground that an owner should not be made to pay the total cost, for example, of refluing a boiler which may have been burned out principally on another owner's work. The other items of cost require no special explanation.

Owners of equipment find occasion to establish rental rates as follows: (1) For a lump sum or unit price estimate; (2) To owners on cost plus work; (3) To others than client owners. In these instances charges should be made as follows:

(1) The rental charge or equipment expense for lump sum work includes all the items mentioned above.

(2) The fixed rate to owners on cost plus work will include all but field repairs, if this item is paid as a cost of the work. To the amount thus determined may be added a service charge depending upon the policy of the contractor, i. e., whether the service of equipment is included in the profit fee or carried in the rental charge.

(3) The charge to persons other than client owners includes all of the items of expense and an additional amount for profit or payment for the machine's earning power.

A further consideration in each of these cases is the rate for double shift work, where the percentages for depreciation and repairs should be doubled, or nearly so.

The committee desires to emphasize the fact that the values presented in the following table should not be considered absolute in determining a rental charge. A real danger presents itself in using any tabular percentage without investigating the conditions under which the equipment is to work. To illustrate, if the values here given for a standard gage shovel outfit were applied to such an outfit engaged constantly in excavating hard rock the probability is that the charges allowed would not cover more than half the expense. The frequent dobey shots and the dropping of heavy boulders into cars entails a higher rate of depreciation and repairs than is given in the schedule. On the other hand, if this shovel outfit were steadily engaged in digging sandy loam the values given in the table would probably cause the equipment charge to contain a fair per cent of profit.

This schedule is offered to contractors with the understanding that individual judgment and experience should be applied to the tabular values to meet unusual conditions.

The component expenses incurred by the ownership and maintenance of construction plant are expressed in this table as percentages of the initial cost for individual items of equipment. They indicate the probable annual expense without profit under ordinary job conditions and should be included in any lump sum estimate or in determining time rate rental charges. The salvage value is considered to be 25 per cent of initial cost.

Total percentage amounts in the extreme right hand column should be applied to the total cost of a machine including charges for transportation from the factory. This gives the total annual charge, which for a lump sum contract covering a full season is the total equipment expense. For determining a monthly, weekly or daily rental rate the annual amount is divided by the number of such periods in the year during which construction work may be carried on.

TABLE FOR COMPUTING RENTAL CHARGES FOR CONSTRUCTION EQUIPMENT

(Insurance 1 per cent; taxes 1 per cent and storage 3½ per cent for all items)

Items of Equipment	Economical Life	Annual Depreciation	Annual Shop Repairs	Annual Field Repairs	Total Annual Charge, Per-cent of Initial Investment
	Yrs.	%	%	%	%
Auto-crane	5	15	6	5	31½
Auto-truck	3	25	20	20	70½
Auto-trailer	5	15	6	5	31½
Backfiller, power	4	18½	6	7	37½
Ballast spreader	8	9½	6	4	25
Boiler, upright	8	9½	20	5	40
Boiler, locomotive	8	9½	15	5	35
Bucket, clam shell	4	18½	15	6	45½
Bucket, orange-peel	4	18½	25	6	55½
Bucket, drag-line	4	18½	12	3	39½
Cars, steel dump	6	12½	8	4	30
Cars, wood dump	5	15	7	3	30½
Cars, flat	8	9½	4	3	22
Cars, hopper	5	15	8	3	31½
Compressor, steam	7	10½	6	3	25½
Compressor, gasoline	4	18½	6	7	37½
Compressor, electric	6	12½	3	3	24
Concrete chutes	2	37½	15	15	73
Conveyor, belt	2	37½	7	6	56
Conveyor, bucket	2	37½	10	6	59
Crusher, rock	6	12½	5	3	26
Derrick, wood	5	15	4	4	28½
Derrick, steel	10	7½	4	3	20
Dragline, steam	6	12½	9	8	35
Dragline, gasoline	4	18½	10	10	44½
Dragline, electric	8	9½	7	7	29
Drill, tunnel carriage	5	15	8	8	36½
Drill, traction well	6	12½	7	10	35
Drill, tripod	4	18½	7	10	41½
Drill, jack hammer	4	18½	7	6	37½
Engine, gas	6	12½	8	8	34
Engine, steam	10	7½	5	5	23
Excavator, cableway	6	12½	4	12	34
Excavator, Keystone	5	15	8	4	32½
Excavator, trench	5	15	8	6	34½
Forms, steel concrete	2	37½	20	20	83
Graders, common road	4	18½	12	6	42½
Graders, elevating	4	18½	15	7	46½
Hoist, steam	10	7½	6	4	23
Hoist, gasoline	6	12½	7	8	33
Hoist, electric	8	9½	5	3	23
Loco. Indus. steam	9	8½	6	4	24
Loco., Indus. gas	4	18½	13	10	47½
Loco., Indus. battery	4	18½	15	4	43½
Loco., Stand. gage	10	7½	6	4	23
Loco. crane, steam	8	9½	7	8	33
Loco. crane, elect.	8	9½	6	4	25
Mixer, steam	5	15	12	4	36
Mixer, gasoline	4	18½	13	8	45½
Mixer, electric	6	12½	12	4	34
Mixer, paving steam	5	15	13	4	37½
Mixer, paving gas	3	25	16	9	55½
Motors	6	12½	6	4	28
Pile driver, steam	8	9½	7	5	27
Pile driver, track	10	7½	5	3	21
Pile hammer, steam	7	10½	7	3	26½
Pipe, galvanized	3	25	5	6	41½
Plows	3	25	15	10	55½
Pneu. concr. mach.	4	18½	20	8	52½
Pump, centrifugal	8	9½	6	4	25
Pump, piston	6	12½	7	5	30
Pump, pulsometer	8	9½	2	4	21
Pump, Emerson	8	9½	2	4	21
Rails	8	9½	5	3	23
Riveter, air	5	15	8	4	32½
Rock channeler	6	12½	7	8	33
Roller, steam road	10	7½	5	3	21
Saw rigs	4	18½	10	15	49½
Scraper, wheel	3	25	8	4	42½
Scraper, slip	1	75	25	10	115½
Scraper, fresno	2	37½	25	15	83
Shovel, steam	6	12½	7	6	31
Shovel, gasoline	4	18½	9	7	40½
Shovel, electric	7	10½	6	5	27½
Switches, fabricated	3	25	3	3	36½
Tower, steel hoist	7	10½	3	4	23½
Tractor, wheel gas	6	12½	9	5	32
Tractor, caterpillar	5	15	15	10	45½
Wagons, dump	4	18½	17	3	44½
Wagons, hauling	4	18½	12	3	39½
Wagon loaders, power	5	15	10	6	36½

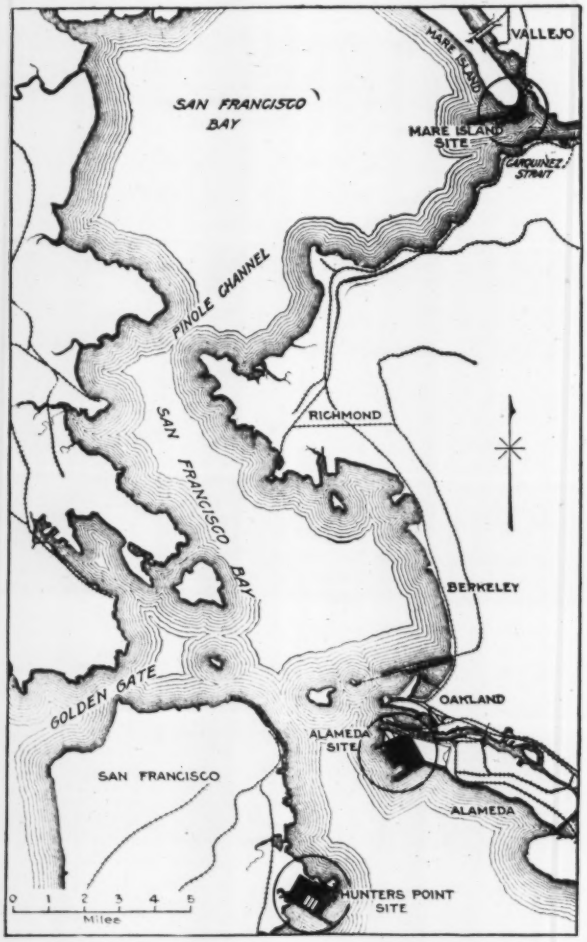
Lumber Cut for 1919

Little variation in the lumber cut of 1919 over that for the previous year is indicated by preliminary statistics of the Bureau of the Census so far available. In 788 identical mills, each of which cut 5,000,000 ft. or more in each year, there was an increase of only 0.3 per cent in 1919 over 1918. On the basis of the production for 1918 this increase will bring the total production for 1919 to 32,000,000,000 ft. The largest increase was in Washington and the largest decrease was in Minnesota.

Three Sites Considered For San Francisco Naval Base

Engineering Considerations Govern in Selection of Location for Large Plant to Cost From $25,000,000 to $50,000,000

NAVAL policy apparently is committed to the immediate construction in San Francisco Bay of a huge naval repair and supply base to cost up to $50,000,000. Reports have been made at different times for some years and a congressional committee has just completed a survey of the situation. It will soon report recommending one of the three sites favored in the earlier reports, namely, Mare Island, the site of the present Navy Yard; Alameda, on the east side of the bay and Hunter's Point in San Francisco proper.



SAN FRANCISCO BAY, NAVAL BASE SITES

Military considerations govern in the selection of a site but it is understood that the balance in this respect is about even and that the selection will hinge on such engineering questions as suitable foundation for the large graving docks, accessibility and service by utilities of all sorts, the providing and maintaining of suitable channels and anchorages and the conservation, so far as feasible, of existing government investment in the Mare Island Navy Yard.

On account of the emphasis laid on the engineering features of the three sites, the matter is a big one in engineering circles on the coast. For that reason there are presented below abstracts of the arguments in favor of each site by engineers who are well acquainted with the situation.

MARE ISLAND SITE, (*By Howard C. Holmes, Consulting Engineer*).—It was universally admitted by naval authorities as late as 1916 that the development of Mare Island as a base for modern fleet units was impracticable for two reasons, (a) the impracticability of maintaining a channel of requisite depth over Pinole shoal in San Pablo Bay, which is the approach-channel to Mare Island, and (b) the constricted width and shallow depth of Mare Island strait, which now constitutes the Navy Yard's waterfront. The Pinole shoal problem has now been solved. In 1916 the army dredged a channel 500 ft. in width and 30 ft. deep at low water and because the silting was less than anticipated the depth was carried to an average of 35 ft. without additional cost. The maintenance expenditure has been relatively negligible. It is now certain that this channel can be maintained to a depth of 40 ft. for any desired width, at a cost and annual maintenance insignificant as compared to the saving over the cost and maintenance of the other proposed naval base site. A plan for improvements at the south end of Mare Island, proposed by Commander Leonard M. Cox, C. E. C., U. S. N., completely solves the Mare Island strait problem because it would place the new major docks and 1,200-ft. piers not on Mare Island strait but on Carquinez straits. This body of water has a depth of 40 ft. and over, a width in front of the proposed base of 4,000 ft. and an anchorage area of 3.55 square miles, greater than any anchorage ground immediately adjacent to 90 per cent of the naval stations of the world. The location of the naval base at Mare Island Navy Yard would mean the retention of a very efficient organization with the wonderful community spirit that exists there. In addition to this, every facility contemplated for the suggested sites in the lower bay could be provided at a cost of more than twenty million dollars less than the cost of providing the same facilities at the other sites. However, this would not represent the total saving because the capitalized value of the cost of a new station, amounting to $50,000,000 should be added to the saving, making a total saving of something like $70,000,000.

ALAMEDA SITE (*By C. E. Hewes, City Manager, Alameda, Cal.*).—The Helm commission report, transmitted to Congress in December, 1917, after eliminating Mare Island as being out of the question for many reasons, stated in substance that the Hunter's Point and Alameda sites offered advantages superior to every other site for the following reasons: (1) lower cost of development for equal areas; (2) proximity to better and deeper anchorage grounds; (3) proximity to labor supply; (4) lower cost of maintaining channels of approach; (5) sufficient area for indefinite expansion. The report further stated that either of these two sites could be developed into a satisfactory base, and although the Hunter's Point site has the advantage that dry docks could be built in rock, rather than upon pile foundation, the Alameda site has many more important advantages, to wit: (1) better foundation for all other structures; (2) site gratis (the land has been deeded by the people of Alameda to the Government for naval base purposes); (3) direct railroad connections (the east shore being the

termini of three transcontinental railroads); (4) better passenger transportation, housing and living facilities; (5) direct pipe-line oil supply; (6) better facilities for handling navy stores; (7) from a standpoint of range for indirect gun fire, Alameda has the advantage of being three to four miles further from the open sea; (8) lower cost of development. A series of sub-surface explorations in the form of fifty-seven test piles was made on the Alameda site. These showed that the material forming this submerged flat consisted very largely of sand, gravel and clay with a comparatively small percentage of soft pockets. The comparative uniform supporting power of this material is advantageous in permitting the site to be developed along the most economical lines as regards relative position of shops, piers, drydocks, etc.

HUNTER'S POINT SITE (*By M. M. O'Shaughnessy, City Engineer of San Francisco*).—A naval base located at Hunter's Point would have favorable foundation conditions for large graving docks. Transportation facilities and utilities of all sorts are already available, there is ample land area, adequate channel depths, and all San Francisco Bay as adjacent anchorage. Next to military advantage, the most important requirement of a good naval base is a solid foundation. On this score Hunter's Point has excellent qualifications in the works already constructed there. At Hunter's Point is a green serpentine rock formation which forms an ideal foundation, is easy to work, impervious to water, and requires only 15 to 18 in. of concrete for a lining instead of the dense mass of concrete necessary for structures on pile foundations. Including the submerged areas that can be readily reclaimed there is, a total of 3,035 acres available for naval base purposes. Just off-shore there is a natural depth of 50 ft. of water with current velocities of about 1½ knots. This makes it easy to land and handle ships, at the same time that the current is strong enough to prevent the deposit of silt. Very little silt comes from the relatively limited watersheds draining into the bay here. Soundings over a 40-year period show very little change in sediment deposits. A particularly advantageous water-supply system, for domestic, industrial and fire-fighing purposes is available.

Airplane Effective in Forest Fire Control

Of the 196 forest fires sighted and reported this year by the airplanes operated out of the Sacramento, Cal., base maintained by the U. S. Forest Service, 33 per cent were located within ¼ mile of the exact location as later determined by actual surveys on the ground. Ten per cent of the total number of fires were discovered by the air patrol before the rangers knew of their existence; 42 per cent of the fires were reported by radio, while the airplanes were in flight. Besides acting as lookout to detect and report fires, airplanes were used this year to direct fire fighting operations and to patrol fire lines which had been built but which needed watching. If reports from the air showed the line to be clear the fire fighters were kept at work elsewhere, but if the observer reported that the fire had broken away a force of men could be rushed to the spot. In addition to the two planes which have been operating daily on fire patrol service from Sacramento, two planes have also been operated from three other stations, namely, Fresno, Riverside, and Red Bluff.

The "Glunch"—Creator of Ideas

IN THE Dec. 16 issue of *Engineering News-Record* there appeared in the article "Useful Dodges in Surveying," p. 1164, a method of determining the day of the month by making an altitude observation on the sun. A member of the advertising staff of the McGraw-Hill Co., who claims that his wonderful mathematical ability was developed by learning how to figure out his income tax, seeing a wide application of the idea, wrote the following classic for the "Accelerator," an intradepartmental bulletin of the advertising service department of the McGraw-Hill Co.:

Well, you can throw your calendar pad away. There is no further use for it now that a writer in *Engineering News-Record* has pointed out how remarkably simple it is to learn the day of the month without the aid of a printed reminder. His method is this:

> If the day of the month has been forgotten make an equal altitude observation of the sun and establish a true meridian. Measure the angle from the meridian to the sun, also the sun's altitude. Compute the declination of the sun by the formula
>
> $$\text{Cos. } Q = \frac{\text{sin. dec.}}{\text{cos. lat.} \times \text{cos. alt.}} - \text{tan. lat.} \times \text{tan. alt.}$$
>
> The sign of the first term of the right-hand side of the equation is minus when the declination is south; the second term is plus where the latitude is south. If the algebraic sign of the result is plus, Q is the angle between the sun and the north point, but if it is minus it is the angle between the sun and the south point. Correct the resulting declination by the hourly distance to obtain the declination at Greenwich. If the observation has been made correctly an inspection of the ephemeris will disclose a declination similar to the computed one, and the date corresponding to this declination is the date of the observation.

As a possible suggestion showing how this idea may be applied to our own work, Ye Editor has worked out a formula for finding a good headline when thoughts on same are completely lacking. It is hoped that copy writers who at times may be suffering from a slump will find this helpful:

If all thoughts are lacking, open up your desk shears and set the points exactly four and sixteen thousandths of an inch apart. Hold the shears three verts from the eye, and measure off the bi-sectional angle which appears on the west wall chart, twenty and one-half bluts from the dixtus. With this as a basis, compute the hypote of the d q juncture thus formed, using the figure 86 as a binominal focus. This will give you the following formula:

$$\text{Polq } Y = \frac{\text{mt. M. D.}}{\text{DDS.} \times \text{Ugh}} - \text{zing. fft.} \times \text{osh.}$$

The sign on the upper terminus of the glunch will give you the Grecian declination, Helios. Box this by north meridian by morain surplus by the ancient symbol of Yat. If the glunch fits the deformation caused by the injection of the post-alterioric dixtus of Yat, then the sub-normadial fluxtures will equal its distance from the basic formation of the parent sidius. If the lines converge, the caleidis thus arrived at will set up a corresponding vertuissuge where the west-wall chart overlaps the dixtus. This will give you the letter of the alphabet.

Follow this formula for each letter and your headline will appear automatically.

Truck Makes 24-Hr., Non-Stop Run

In a recent test made upon the Indianapolis speedway a stock model of the Duplex truck, loaded with gasoline, oil and ballast and weighing 8,300 lb., exclusive of drivers, made a 24-hr., non-stop run at an average speed of more than 38 mi. per hour, running the total distance of 930 mi. between 1:57 p.m., Sept. 30, and the same hour the following day.

Better Port Terminals to Develop Nation's Commerce

Abstract of paper by Col. W. J. Wilgus, consulting engineer, New York City, Am. Soc. C. E. PROCEEDINGS, November, 1920, as a discussion of a paper, "Larger Ships, Deeper Harbors, and Better Dredges," presented Oct. 6, 1920, by A. W. Robinson, consulting engineer, Montreal.

THE maritime nation offering the lowest freight rates and best shipping service through superior development of ships and ports will have a pronounced lead over its competitors as instanced in Mr. Robinson's paper and his former paper (*Journal*, Engineering Institute of Canada, February, 1919), summarizing the opinion of British authorities that the development of future world trade will depend on increase in size and drafts of ships and consequently on the improvement of ports properly to serve them. Americans should undertake development of their principal ports to provide ample accommodations, as for instance vessels of the type mentioned by Mr. Robinson having a length of 660 ft., a loaded draft of 36 to 38 ft., and a dead-weight capacity of 25,000 tons.

For proper accommodation of such ships, as the author so well states, channel and slip depths should be not less than 40 ft., with provision for future deepening to 50 ft. There should also be provided trackage for direct interchange between ship and car; electric gantry cranes and other mechanical devices for quick handling of widely varying weight and bulk; slips of generous proportions for movement of ships and all auxiliary water craft; piers of sufficient width for receiving, forwarding, sorting and temporary storage of cargo and for the location of cranes, tracks and vehicular driveways. The aim of such an arrangement is to hasten to the utmost the release of ships, cars and motor trucks, to minimize manual labor and to dispense with the need for ship tackle.

PIER WIDTH A FUNDAMENTAL CONSIDERATION

In the fundamentals of port design pier width is of special importance. The 25,000-ton ship will occupy say 700 lin.ft. of stringpiece, approximately equal to 36 long tons of dead weight capacity per lineal foot. While some consider that shedded "transit" space should be made sufficient for the entire cargo, others believe that one-quarter the cargo may be immediately evacuated from the pier. For the entire cargo, figured at 60 cu.ft. per ton or say 50 cu.ft. per ton of ship's dead weight capacity, equal to 1,800 cu.ft. of goods, with mechanical equipment for tiering 12 ft. high to an average height of 10 ft. for the entire area of shedded space and with suitable provision for aisles and passages, the width of shed required would be 180 ft. For three-quarters of the cargo or 27 tons per lineal foot of stringpiece requiring shedding, in conjunction with the usual ship-ton figure of 40 cu.ft. per ton and an average height for tiering by hand of 4 ft. (5 ft. on the actual space occupied), the width of shed required would be 270 ft. It may be said that a fair compromise between these extremes is 200 ft., to which, of course, there should be added a suitable width for outer tracks and working space between edge of pier and shedded area, and likewise ample interior widths for inner tracks and motor truck driveways.

For double-sided piers this would mean an aggregate width of not less than 550 ft., the lower floor of which would be used for inbound and the upper floor for outbound cargo. Even with a ship of half the capacity under discussion, the pier width should be not less than 340 ft., with all equipment, track and driveway layout having proper relation to the length of the pier. With overhead warehouses there would be need for even greater widths, for additional serving tracks and driveways. These figures are used in a general sense and should be considered merely as indicating the need for adopting liberal widths.

The only 40-ft. channel on the Atlantic coast is at New York, and unfortunately, is now available for little more than one-half of one per cent of that port's 771 miles of water front. Of this meager percentage only one-half is in direct contact with the principal rail carriers, and a considerable portion of deep-water frontage is devoted to uses other than those of legitimate water-borne commerce. And there is as yet nothing planned, apart from the projected Claremont Terminal of the Lehigh Valley R.R., in the way of spacious and well equipped modern piers and accessories, properly adapted to the prompt handling and release of large ships, cars and motor trucks. According to press accounts, several great transatlantic companies intend building new piers on the west side of the Hudson River; but it is reported, as in the case of the New York City Staten Island development, that advantage is not to be taken of the proximity of trunk line railroads to provide tracks on the piers and adequate shedded "transit" areas, so that the railroads and therefore indirectly the public will continue to be burdened with the wasteful practice of rehandling freight by lighter and truck between the termini of rail and ship, and with highly objectionable delays to cars from their use for storage.

EFFECT OF RATE STRUCTURE

One of the causes is unquestionably the provision in the seaboard rate requiring railroads to deliver and receive cargo freight at the ship sling, with no voice in the planning of pier facilities. Another cause is the practice of permitting the lessee, the ship owner, to dictate the character of the port terminal improvement. The result is the creation of piers at the least possible cost to ship interests regardless of the injury done to land carriers, both rail and truck.

The various transportation interests of New York should get together to bring about (a) the revision of the rate structure and more equitable methods of paying for the use of shore facilities properly to distribute cost between rail and water carriers; (b) plans conducive to economies in operation and quick release of ships, cars and motor trucks; (c) whole-hearted co-operation by the Federal government will mean a great deal for the country as a whole.

It should be borne in mind that the investment in port terminals is a comparatively small fraction of the aggregate investment devoted to the combined ocean and rail movement of freight. Therefore a liberal expenditure for the perfecting of the lesser part is fully justified if substantial benefits therefrom will accrue to the plant as a whole, in which are included ships, cars and motor trucks, as well as the shore facilities in general.

[As of interest in connection with Colonel Wilgus' discussion of the requirements fundamental to a satisfactory solution of harbor terminal development, there is published on the opposite page the "Policy" of the Port Development Commission of Baltimore.—EDITOR.]

Large Floating Crane Built in Holland

A self-propelled floating crane of the Atlas type capable of lifting 220 tons, has just been built by A. F. Smulders, of Schiedam, Holland, for the Mersey Docks and Harbor Board at Liverpool. The crane is one of the largest, if not the largest, of its type ever built. It is capable of lifting its maximum load at a reach of 110 ft. from center line to a height of 170 ft. above water, or of lifting 150 tons at a reach of 143 ft., according to *The Engineer* (London) of Oct. 15, 1920. The extreme height of the end of the jib when raised to its highest position is 240 ft. above water. There are two independent main hoists of 110 tons capacity each, attached at a point on the jib having a maximum distance out of 143 ft. They hoist at 3½ to 5 ft. per minute. For lighter service two 33-ton hoist trolleys running along the jib can be used independently or coupled to move together, so that they are capable of handling 66 tons combined; their lifting speed is 18 ft. per minute and traverse speed 29 ft. per minute. The crane was erected complete at Schiedam and was towed to Liverpool with the jib in place.

Baltimore's Port Development Policy

AS AN INITIAL declaration of policy, in undertaking harbor development work, for which $10,000,000 can now be made available, as required by new shipping business, the Port Development Commission of Baltimore, Nov. 8, 1920, adopted nine general requirements published in full below:

It shall be the policy of this commission

(1) To develop the port of Baltimore in accordance with a definite and comprehensive working plan, based on the best modern conception of port design. This plan shall serve as a guide for each step in the development in order that the completed whole may be harmonious in the correlation of its individual parts.

(2) To consider the elemental function of a pier the furnishing of a safe means for the expeditious and economical interchange of freight between land and water carriers and not merely the furnishing of a shelter for a ship so as to insure stability during the process of loading and unloading.

(3) To make improvements for the broad purpose of the widest possible use and benefit of the port as a whole and not solely for the narrow purpose and restricted use by meeting only present conditions or the special requirements of prospective lessees. All structures shall be readily adaptable to future changes in kinds of cargoes, methods of operation and special requirements of future lessees.

(4) To obtain expeditious movement of cargoes between land and water carriers and a maximum of economy by constructing piers large enough to hold the full contents of vessels which can tie up to them, and by making proper provision for the installation of mechanical appliances and facilities to move these contents to or from the piers with the least possible delay to vessels.

(5) To locate all improvements preferably in places where it is possible either now or at some future date to make railroad connections with all the trunk lines entering the city, and to locate warehouses, wherever practicable, so that there will be the shortest possible movement of cargoes from the carriers to the place of storage.

(6) To provide the space and the supports for ample railroad tracks on both the inside and outside of piers so that these tracks may be added at any time required.

(7) To construct transfer sheds with at least two stories wherever the business of the lessee warrants such construction, and when only one story is required at time of construction, to design the foundations and the framework in such a manner that an additional story can be added at any future date with the least possible interference with the operations on the first story.

(8) To build all structures with the primary conditions of stability, permanency and economy.

(9) To have in view

(a) The ultimate concentration of terminals and shipping facilities so that the combined railroad trackage may be made accessible to all piers, and

(b) The unification of the administration of the terminals and shipping facilities so as to assure co-ordination and co-operation of all interests.

J. E. Greiner, consulting engineer, Baltimore, is chairman of the Port Development Commission. $10,000,000 will become immediately available for the building of new piers as soon as lessees are found and $10,000,000 will become available later, in accordance with the recent Baltimore bond issue vote, aggregating $53,000,000. It is expected that work will start early in 1921.

Australian Engineering Jubilee

The 50th anniversary of the Engineering Association of New South Wales was celebrated at Sydney, Sept. 24, At a meeting held in that city Sept. 24, 1870, and called by John Laing an association of mechanical engineers was organized, its first president being John Fyfe, mechanical and marine engineer. Speakers included James Vicars, president; Prof. Warren, president, Institution of Engineers of Australia; James Fraser, chief railway commissioner of New South Wales.

Double-Deck Street and Sidewalks for Congested Chicago

SUGGESTIONS for the relief of congested streets in Chicago made by P. S. Combs, city engineer, include double-deck sidewalks in the downtown or loop district and elevated roadways in the center of certain streets leading from the loop. The upper sidewalks would take 50 to 60 per cent of the pedestrians off the present sidewalks. The roadways would expedite night and morning automobile traffic, taking 40 to 50 per cent of the fast-moving vehicles from the present street levels. They would be operated one way only, out at night and in in the morning. By depressing the street car tracks a few feet and erecting a through-girder roadway structure the usual objection to a double-deck street as to cutting off of light and unsightliness would be minimized.

Other suggestions to improve traffic conditions are: Several underground parking spaces to remove automobiles from the streets during the day; a restriction of heavy-truck traffic to streets provided with reinforced-concrete tracks, and a prohibition of deliveries of heavy supplies during the day time.

In making these suggestions Mr. Combs classifies the traffic as follows: Street cars; automobiles and light vehicles for general business; package and heavy freight haulage for commercial shipment; pedestrians; heavy supply trucks for coal, building materials and quantity supplies for the larger stores. It is his opinion that all of these factors must be considered together since piecemeal solution simply works for the betterment of one to the detriment of the other. The creation of a commission representing all of the interests concerned, to study traffic and to devise means to prevent undue destruction of pavements, is now under consideration by the judiciary committee of the City Council. An ordinance prohibiting any parking in the downtown district beyond that necessary to load and unload passengers or freight has recently been passed in an endeavor to speed up street car and vehicular traffic.

New Garbage Collection Equipment for Dallas

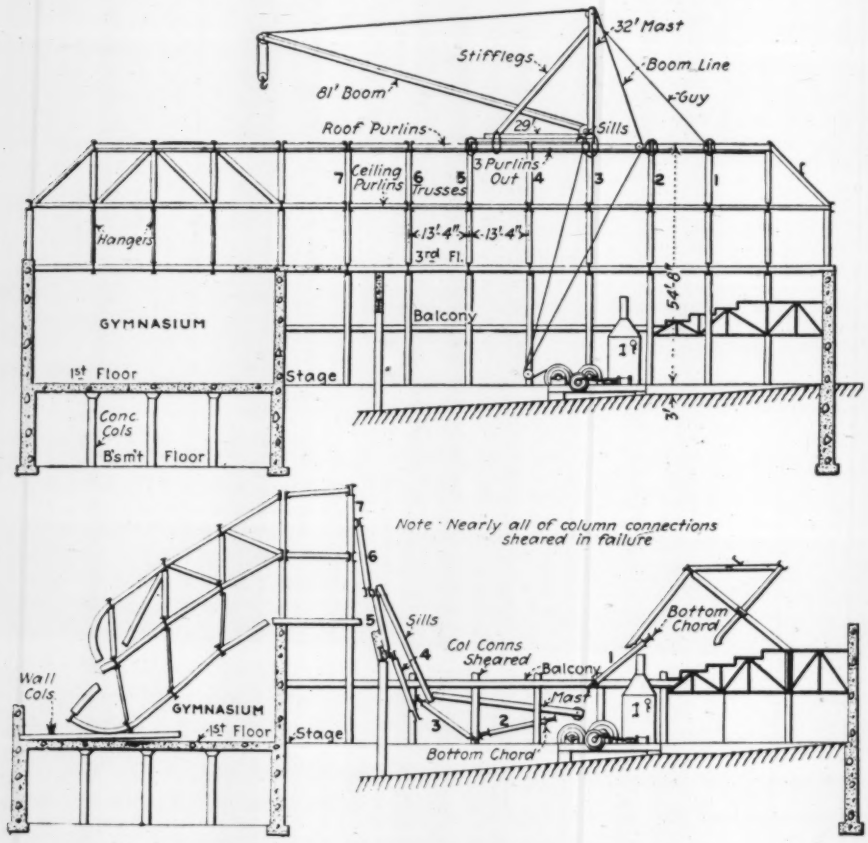
The city of Dallas, Tex., is putting in use a new system of garbage collection. For this purpose new equipment has been purchased, consisting of 40 two-ton, drop-frame, reversible chassis, with 4½-yd. side dump steel bodies. Twenty teams will be used to draw these trailers for the collection of garbage and its haulage to a central point, from which six motor trucks will take the trailers to the garbage dump. The teams, trailers and tractors are divided equally between five districts.

The garbage at Dallas is collected four times each month. It is very light, weighing only 600 lb. per cubic yard. Under the old system of collection there were used 60 team-drawn, 7-yd. wagons and four 9-yd. motor trucks. Each team made two loads per day.

A thirty-day survey showed that each team spent 2 hr. 58 min. per day in loading garbage into the wagon and 5 hr. and 2 min. in going to and from the dump and unloading the garbage. Under the new system each team will spend 8 hr. in the collection of garbage only. It is expected that the same service will be given at a great decrease in cost. For the foregoing information we are indebted to George D. Fairtrace, city engineer of Dallas.

Erection Derrick Falls With Steel Framework of School

THE collapse of a school building in Indianapolis during construction, a few weeks ago, proves upon investigation by the building authorities and the coroner to be a case of highly unusual kind. The steel roof trusses and columns, insufficiently braced by the brickwork of the walls, were pushed over laterally, to all appearances by the side thrust of a derrick set on the top chord of one of the trusses. The entire upper portion of the building was involved in the resulting collapse, as the purlins connecting the several trusses pulled down not only the trusses nearest to the point of initial failure but also a set of trusses at right angles to these in an adjoining portion of the building.



INDIANAPOLIS HIGH SCHOOL BUILDING BEFORE AND AFTER COLLAPSE—LONGITUDINAL SECTION

Walter B. Stern, commissioner of buildings of the city, has supplied sketches reproduced herewith, and states the facts of the accident as determined by the investigation, as follows:

The building was designed to provide an auditorium 90 x 106 ft. and a gymnasium 54 x 90 ft. on the first floor, with balconies at the second-floor level. The balconies at the sides of the auditorium were of reinforced-concrete tile construction, and were in place and hardened at the time of the accident. The entire third floor, designed to be used for a students' lunchroom, was suspended from the roof trusses; of this floor only a small section over the gymnasium was poured, while over the auditorium forms had not even been placed. All the roof trusses and their supporting columns were up. The trusses over the auditorium ran crosswise of the building, being supported on trusses on steel columns about 9 ft. in from the outside walls. The trusses over the gymnasium ran lengthwise of the building (across the 54-ft. width of the gymnasium) and rested on steel columns. The trusses were completely riveted up, but the roof and ceiling purlins, the connections to the columns, and the column splices were only bolted temporarily. The side walls had been laid up only a few feet above balcony level.

Witnesses at the coroner's investigation, conducted with the assistance of representatives of the city's building, police and fire departments, testified that more than half of the holes in these various connections had bolts in them, but the steel structure was not properly guyed to provide the necessary bracing until the walls should be built high enough to brace the structure.

A wooden stiff-leg derrick with 32-ft. mast and with 12 x 12-in. wooden boom 81 ft. long, had been placed on the top chord of one of the roof trusses five or six days previous to the accident. The derrick was rigged and in service on the morning of the accident. The brake lining on the boom-hoist drum of the hoisting engine was practically worn out, and it is probable that the boom was handled in a jerky manner when being lowered.

It was determined at the investigation that the cause of the accident was the improper rigging and operation of the derrick before the steel structure was adequately braced and riveted. The roof trusses were designed to support a load in the finished building many times the weight of the derrick. Testimony given at the investigation supports the view that an unusual thrust caused by the operation of the derrick sheared a connection between a roof truss and its column, causing the truss to start down at one end. The pull on the purlins then brought about the collapse of the remainder.

Yellow Fever in Ecuador

The elimination of yellow fever from the coast towns of Ecuador, as the result of several years of a sanitary campaign, is reported in the *Bulletin* of the League of Red Cross Societies for October, 1920. The last case at the city of Guayaquil is said to have occurred on May 22, 1919. The stegomyia mosquito, carrier of the disease, has practically disappeared.

LETTERS TO THE EDITOR

Does Hydrated Lime Weaken Concrete? Abrams' Tests Discussed Pro and Con

Sir—Prof. Duff A. Abrams of Lewis Institute has rendered a real service to the concrete world through his long series of tests to determine the effect of hydrated lime and other powdered admixtures in concrete. He broke 20,000 specimens, which is far and away, the greatest undertaking ever attempted in this line. This makes it especially a pity that the conclusions which Prof. Abrams draws in his paper before the last meeting of the American Society for Testing Materials, abstracted in *Engineering News-Record*, July 8, 1920, p. 55, are at variance with his figures. In a very proper effort to be thorough in covering the field he has investigated ranges of all the variables, far outside of practical limits. No one can disagree with this, but when the attempt is made to establish straight-line relations by the use of these figures, or to average them in with practical ranges, or to say that because extreme amounts of lime are injurious small amounts will be also, it becomes necessary to refer the public to the figures themselves. Let us quote some of the conclusions drawn from the paper and indicate wherein they are not substantiated.

Conclusion 1—"In general the addition of powdered materials reduced the strength of concrete approximately in proportion to the quantity of admixture. Some exceptions are noted below."

Here all the specimens have been averaged together whether they contain small amounts of lime or 50 per cent, and the statement is made that the "relation is a straight line"; but many of the curves reveal the vital fact that small amounts increase the strength, even though larger ones reduce it. This is so evident in one figure after another that more study of the usual amounts of lime used seems to be necessary. Practically one-half of the curves and tables referring to compressive strength display points and figures higher than the corresponding plain specimens. These are mostly within the maximum percentages used in practice as follows:

Concrete	Hydrated Lime Per Sack Cement	Proportion By Volume
1:3 :6	12 lb.	30 per cent
1:2½:5	10 lb.	25 per cent
1:2 :4	8 lb.	20 per cent
1:1½:3	5 lb.	12½ per cent

(For waterproofing purposes, 15, 12, 10, and 7 pounds respectively.)

Conclusion 2—"In usual concrete mixtures, each 1 per cent of hydrated lime (in terms of the volume of cement) reduced the compressive strength 0.5 per cent."

Mixtures 1:1½:3 and 1:2:4 are the only ones considered here as usual mixtures, and 1:2½:5 is completely ignored although an enormous yardage of it is placed every year. Readers who examine the figures and tables will see for themselves that there is a region wherein lime increases the strength of concrete and a very much larger one where the laboratory losses in strength are more than overcome by the advantages. The qualities attributed to lime in concrete which account for its rapid progress of late years are not increased strength as hinted at by the author but prevention of segregation, easier flow in chutes and around reinforcement, reduction of honey-combing, smoother surfaces and watertightness. Throughout the paper it is assumed that immediately we begin adding lime we begin reducing the strength, in other words, "the relation is a straight line." The plotted points and figures, however, do not sustain this claim, as can be clearly seen when the curves are not drawn "by eye" as in the paper, but by some mathematical method. For instance, in Fig. 2 only two exceptions and eleven cases of increased strength within the limits; in Table VII, of 18 groups of tests only three failed to show increases of strength with lime; in Fig. 1 three-fourths of the curves show no considerable decrease within the limits; and particularly the summary in Fig. 1 in which all of the so-called straight-line curves are below the 5 and 10 per cent points and where within the usual limits no case of decreased strength is shown.

Conclusion 4—"The addition of 1 per cent of the following powdered admixtures in terms of the volume of cement reduced the strength of 1:4 concrete at 28 days by the following percentages: hydrated lime . . . 0.56 . . ."

But 1 per cent of lime was not added at any point in the tests, and this is one of the many places where mistaken impressions are conveyed. Furthermore, all specimens have been averaged together by the straight-line method referred to above, which conceals the effect of small quantities of lime. It is a coincidence that 28 days is the age which makes the worst show for lime, and it is unfortunate also that 1:4 concrete is given so much prominence when only five pounds of hydrate per bag of cement is used in practice. Table XV shows very clearly that further study of small amounts of admixture is necessary. Here 1 and 2 per cent of mica, pitch, gypsum and ironite are added to the concrete and substantial increases in strength are shown, even though larger amounts do decrease the strength.

Conclusion 6—"Rich concrete mixes showed a greater loss in strength due to powdered admixtures than the leaner ones. In lean mixes (1:9 to 1:6) and those with aggregates graded too coarse for the quantity of cement used, the strength was little affected or was slightly increased by admixtures up to 50 per cent."

Under lean mixes, 1:2½:5 is included, and once more attention is called to the large yardage placed every year, in which even with large amounts of lime it is admitted that strength is increased.

Conclusion 7—"The wetter mixes showed a greater loss in strength than the dry, due to the addition of hydrated lime." Water is usually added in these wet batches for the sake of improved plasticity. Table XVI shows very decided improvement in the plasticity when lime is added, and indicates that it is unnecessary to use so much water in the lime batches in order to secure equal plasticity. This being the case, it is only fair to credit lime with a portion of the increased strength of the drier batches. Fig. 7, for instance, shows that 50 per cent of lime increases the strength up to 75 per cent, if no water is added, and this increase should be divided between the effect of the lime and the effect of the dryness.

Conclusion 10—"Hydrated lime and other powdered admixtures used in these tests slightly increased the workability of the leaner mixes (1:9 and 1:6) as measured by the slump test. Ordinary mixes (1:5 and 1:4) were little affected; richer mixes (1:3 and 1:2) were made less plastic."

It is easy to find fault with the slump test; for instance, as the very first value under normal consistency where ½ to 1 in. slump is expected, we find 6.1 in.; but with all of its faults, the slump test is the best one we have for measuring plasticity, and some judgment can be formed from these results.

The effect of lime may best be realized by comparing the average slump in each column with the corresponding slump without lime. In 36 of these averages (including all mixtures and all percentages of lime), only 11 are less than the straight cement specimens. The increases with lime are 1:6, 31 per cent; 1:5, 112 per cent; 1:4, 37 per cent; 1:3, 19 per cent; 1:2, 12 per cent. This states that "for the richer mixes the slump was decreased," but it is seen in 1:2 concrete 5 per cent of lime increased the strength 26 per cent, and 10 per cent of lime, 34 per cent, averaging all consistencies. The four richer mixes average a steady gain up to 33 per cent.

Conclusion 11—"The wear of concrete was not sensibly increased by hydrated lime or other admixtures up to 20 per cent of the volume of cement."

Table XI cites ten cases of which seven average 8 per cent less wear when 10 per cent of lime is added, and the eighth case wears better with 33 per cent of lime than without. The average of all specimens containing 10 per cent (which is about the maximum amount used in practice)

reveals that there was 2.7 per cent less wear. In Tables XX and XXI, four-fifths of the cases where 5 per cent of lime was added show less wear than the average of all specimens up to the maximum of lime used in practice.

Conclusion 12—"The bond resistance was affected in the same manner as the strength by the presence of hydrated lime."

Four ages are studied here, but as only two of them show decreased strength, one can hardly draw any conclusions. In this study, lime was substituted for rather than added to the cement, which practically invalidates the figures.

Conclusion 13—"Hydrated lime had little effect on the absorption of dry concrete, increased the evaporation of water from wet concrete and produced no beneficial effect on the strength of concrete stored in air."

These curves are so close together that it is hard to see how one can conclude that evaporation was increased.

It is felt that these figures show that lime in concrete in the amounts usually added, does not reduce strength, but aids considerably in improving the plasticity, resistance to wear, volume, and freedom from voids. Lime is not hydraulic and damp sand storage is not a favorable condition for it, but 88 per cent of the specimens were so stored. Under conditions more like actual practice, the lime specimens would undoubtedly have made even a stronger showing. As a whole, however, the work was well planned. A wider scope than ever before was attempted with more refined methods and more thought to eliminate errors. There are many erratic figures, but the series as a whole compares well in this respect. Suitable emphasis in the results has not been given to the vitally significant matter of determining how much lime can be added before beginning to reduce strength.

Washington, D. C. L. H. HART,
Nov. 23, 1920. National Lime Association.

[The above letter was submitted to Prof. Abrams, whose reply to Mr. Hart follows.— EDITOR.]

Sir—The writer is glad to take advantage of this opportunity to reply to the criticisms of our report on "Effect of Hydrated Lime and Other Powdered Admixtures in Concrete." It is unfortunate that the text of our report is not available; however, it will be published at an early date in the 1920 *Proceedings* of the American Society for Testing Materials.

It was a surprise to the writer that Mr. Hart comments somewhat adversely on the wide range of our tests. Many years' experience in testing concrete has shown that it is necessary to cover a wide range in order to determine the underlying principles. A large portion of the concrete tests reported in literature are almost worthless because they do not cover a sufficient range to give conclusive values. Instead of considering the wide range of the tests a weakness, we believe that it is just that feature to which the report owes its principal value. If the tests had been restricted to a narrow range of hydrated lime percentage, consistency, or cement content, we could not have discovered underlying relations. A great many engineers have been seriously misled by attempting to draw conclusions from narrow ranges of concrete tests.

There is no reason why undue weight should be given to the higher percentages of hydrated lime, if one is not interested in those values. The data are given, but attention can be concentrated on the smaller percentages if desirable. Whether or not the 50 per cent values are considered has little or no influence on the conclusions.

Re Conclusion 1—We were primarily interested in the *general* effect of inert powdered admixtures in concrete. Many powdered admixtures besides hydrated lime are of interest to concrete engineers; 17 other materials were used in our tests. The conclusions should be interpreted on this broad basis rather than with hydrated lime only in view. The tests show that certain types of admixture (pulverized granulated blast furnace slag, for example) *are beneficial to concrete strength*, possess all the advantages of hydrated lime and probably can be used at a lower cost.

Mr. Hart makes two errors in stating that "all the specimens have been averaged together whether they contain small amounts of lime or 50 per cent." (1) The values were *not averaged*, but the effect was determined from the slope of the curve plotted as described below, and fully explained in the original report. There is no reason for anyone falling into an error on this point. It conveys an entirely erroneous impression to say the values were averaged. (2) This conclusion was not based on *all specimens*, as the reader who had the original report before him would readily discover. Conclusion 5, which Mr. Hart omits, stated that "Pulverized slag up to 50 per cent of volume of cement gave a slight increase in strength of concrete . . ." This was one of a number of "exceptions noted below"; other exceptions were covered in Conclusion 6 which Mr. Hart quotes.

The expression "relation is a straight-line" which Mr. Hart places in quotation at two points, does not appear in our report. It is not good English and, as stated, does not indicate what we considered to be the facts. The statement (on page 17) was "It will be noted that in these figures the relation between the strength and the volume of hydrated lime used is *essentially* a linear one."

The effect of hydrated lime was studied by plotting the strengths against the percentages of hydrated lime and drawing a smooth curve through these points. In general, curves drawn in this way closely approximate straight lines. The average slope of these lines was taken as a measure of the effect of powdered admixtures on the strength of concrete. The fact that some of the curves and tables contained values with small percentages of hydrated lime which are higher than those without hydrated lime, has no significance, unless we inquire into the cause of the effect found in each instance.

It is clearly stated in our report that there are regions where hydrated lime increases or does not materially reduce the strength of concrete. These cases may in general be classified under: lean mixtures; fine aggregates; and accidental variations in the values which do not affect the general trend of the results. The effect of hydrated lime under the first two headings is fully covered by the tests and the discussion in our report. Accidental variations in tests are discussed below under Conclusion 4.

Mr. Hart objects to our using percentages of hydrated lime higher than those recommended for use in concrete. He does not state on what information those recommendations are based. He also criticises us for not investigating the effect of hydrated lime below 5 per cent; yet the smallest percentage recommended is 12½ per cent (by volume).

Re Conclusion 2—It should be stated that we are dealing with facts and not fancies. There has been ample opportunity for presenting evidence to show that hydrated lime prevents segregation, produces easier flow in chutes, etc., as claimed by Mr. Hart. The only tests with which we are familiar that were carried out specifically for the purpose of studying these points do not verify these claims.

The "by eye" method of drawing curves through plotted points is universally used by engineers; it is quite satisfactory and surprisingly accurate. The nature of the mathematical methods suggested is not divulged. It was not considered necessary to go into an elementary discussion of curve-tracing. The cause for minor discrepancies in concrete tests should be apparent to any engineer conversant with this subject.

It is not clear why Mr. Hart has placed particular emphasis on Fig. 2, in which a number of the curves were derived from tests made on lean mixtures which, as pointed out in our report, show an increase in strength with hydrated lime. We are at a loss to understand how anyone can interpret Fig. 1 as showing an increase in strength of concrete due to the presence of hydrated lime.

Re Conclusion 4—The absurdity of studying the effect of hydrated lime by adding 1 per cent of this material to concrete must be apparent to anyone experienced in concrete tests. The absurdity should be all the more apparent to one who has our report before him, since it is stated in a number of places that 1 per cent by volume of hydrated lime reduced the strength of ordinary concrete mixtures about 0.5 per cent. The most careful concrete tests will

show variations of several per cent, unless a large number of tests are made in establishing each value.

Mr. Hart has overlooked the fact that we are stating a *rate*. It is not necessary that our observations be restricted to 1 second in determining that a pulley is running 2.1 revolutions per second. It is not necessary for a machine to run for an hour to establish the fact that it can be run at 30 miles per hour.

Mr. Hart has pointed out that hydrated lime makes its poorest showing under the conditions in which concrete is usually used and tested, that is (a) aggregate graded 1½ in.; (b) consistency 1.10, which represents the best consistency for road construction and other high-grade work; (c) age 28 days. All designs are based on the 28-day strength of concrete. Most concrete engineers are coming to a saner use of mixing water. It does not seem practicable to modify the accepted sizes of the aggregate for the benefit of hydrated lime.

Re Conclusion 7—The comments are not borne out by the tests. In order that concrete containing hydrated lime may be plastic, sufficient water must be added to produce a plasticity in the lime which approximates that of the concrete. The statement "that it is unnecessary to use so much water in the lime batches in order to secure equal plasticity" does not change the observed facts.

Mr. Hart has misinterpreted Fig. 7, in spite of the explanatory notes which accompany that figure and in spite of the fact that this error has already been pointed out on a number of occasions. It is stated in our report that this table does not show directly the effect of hydrated lime on the strength of concrete. We went so far as to give an example illustrating this very point, so that the most careless reader has no excuse for misinterpreting the diagram. This diagram shows the fundamental relation between the strength of concrete and the water-ratio. While it is true that for the *same water-ratio* the strength of concrete with 50 per cent of hydrated lime is higher than that without hydrated lime, we must not lose sight of the fact that the water-ratio must be *increased* when hydrated lime is used. If the *same quantity* of water were used (the same water-ratio) the concrete containing hydrated lime will be less plastic; allowance must be made for this condition by adding water, which in turn reduces the concrete strength.

By identifying some of the points on the two curves in Fig. 7, the absurdity of his interpretation would have become apparent. Consider, for example, the 1:5 tests (identified by four solid circles), which in the diagram without hydrated lime gave a strength of about 2,600 lb. per sq.in. with a water-ratio of 0.87. In the diagram with hydrated lime these points will be found at a strength of about 2,100 lb. per sq.in., with a water-ratio of 1.10. In other words, the strength is reduced 500 lb. per sq.in. due to the presence of the additional water and hydrated lime. For richer mixes the difference in strength will be much greater for the same difference in water-ratio.

Re Conclusion 10—We have not claimed that our method of measuring the consistency or plasticity of concrete is perfect; in fact it is quite apparent that this is not the case. We are still searching for a better method. Our conclusions are based on a careful study of several thousand determinations by the slump test, only part of which are given in our report. It was pointed out that the slump of leaner mixtures was increased with the addition of hydrated lime (accompanied, of course, by the addition of water).

Mr. Hart's method of calculating the percentages in the discussion of the slump test is erroneous. By this method if a cylinder slumped 7 in. and we get "an increase of 112 per cent we would then calculate a slump of 14.8 in. which is absurd, in view of the fact that a 12-in. cylinder was used.

Re Conclusion 11—Our conclusion with reference to the effect of powdered admixtures on the wear of concrete was based on all wear tests made in this investigation, none of which have been omitted from the report. If we are permitted to select certain data and ignore others almost anything can be proven.

Re Conclusion 12—With reference to the substitution of hydrated lime for cement, it may be stated that some of these tests were made over three years ago, when it was common for the advocates of hydrated lime to recommend the substitution of lime for cement. We recognized that this was a poor practice and it was not followed in later tests.

DUFF A. ABRAMS,
Professor in Charge, Structural Materials Research Laboratory,
Chicago, Dec. 11. Lewis Institute.

Engineers Urged to Join Scientific Bodies

Sir—As you doubtless know, the scientific societies are passing through difficult financial conditions due to the high cost of printing. Their only salvation, outside of increasing the dues unreasonably, is to increase their membership, and I am taking this opportunity to call the attention of the engineering profession to the desirability of becoming members of the American Mathematical Society, the Mathematical Association of America, and the Association for the Advancement of Science.

In joining these societies the engineers will not alone furnish the much needed financial aid in promoting and keeping alive the necessary and important work that these societies are performing, but will also derive much benefit to themselves from contact with the pure science societies.

It must be borne in mind that, after all, the proper carrying on of research is practically impossible without a thorough co-operation of pure scientific bodies, and as these societies eagerly look forward to analyzing and discussing the problems of the engineering profession, there is to my mind no doubt that much mutual benefit must result from an infiltration of the engineering profession in the mathematical and scientific societies.

A perusal of the publications of the three societies mentioned above will show that they contain much of interest to engineers. The editors will gladly open their columns to the presentation before scientists of important engineering problems.

I sincerely hope that this appeal will meet with immediate response, and with the aid of engineers the societies will be carried through the present financial storms.

G. PAASWELL,
New York City, Dec. 23. Consulting Engineer.

Automatic Recorder for Stream Discharge

Sir—In your issue of Dec. 9, 1920, p. 1124, appears a description of the Moore attachment as used in an "Automatic Recording Apparatus for Stream Discharge."

This invention consists of a cam to actuate the recording pencil, which draws a curve whose ordinate is directly proportional to the discharge of the stream and not to the altitude of the float. The idea of this invention occurred to the writer of this letter more than three years ago and he published an account of it, with applications to the stream discharge over both triangular and rectangular weirs (so far as the mathematical work was concerned) in an article which appeared in *The Cornell Civil Engineer* for November, 1917.

The writer has never patented his invention and the two-year limit having expired he supposes that it is now public property—though for aught he knows Mr. Moore may have brought out the idea prior to November, 1917, and may have patented it. IRVING P. CHURCH.

Cornell University, Ithaca, N. Y., Dec. 17.

Piles From Blight-Killed Chestnut Trees

Sir—The question has recently been brought to the writer's attention whether it is safe to use chestnut piles which have been cut from chestnut trees in Connecticut. Inasmuch as the chestnut trees in this locality have been killed off by a blight within the past few years, I question the advisability of using this wood for piles. If any of your readers have records of tests on the use of such piles, the writer would appreciate receiving information regarding it.

Bridgeport, Conn., Dec. 13. EDWARD A. LAMBERT,
Fletcher-Thompson, Inc., Engineers.

In Behalf of the Butte Civil Engineers

Sir—I wish to take exception to the article on Butte appearing in *Engineering News-Record*, Nov. 25, p. 1032. It is certainly ill advised and incorrect.

The Anaconda Copper Mining Co. is much the largest operator in this district. This company maintains a large staff of able engineers in Butte composed of mining, civil, electrical and mechanical engineers and geologists. The slur on civil engineers in the article referred to will appear most absurd if you read the articles on mine surveying which appear from time to time in the paper published by the company. The cross-cuts and tunnels in the Butte mines, if placed end to end, would reach from New York to London, and the underground working in the Butte district are probably as intricate as those of any mining district in the world.

At Anaconda the engineering staff is very large and comprises metallurgical, mechanical, civil (including hydraulic and structural) and electrical engineers. This force ranges between 120 and 300 men.

I take especial exception to the paragraph next to the bottom of the first column of your article. It reads as follows: "There are no civil engineers to speak of at Butte. Outside of the water company and the Montana Power Co. there is no civil engineering to be done. What civil engineers there are are masquerading as mining or metallurgical men and from the looks of the main footbridge leading to the big smelter at Anaconda—a nice wood truss with no sign of post or diagonal, a perfect tribute to the efficiency of the arch, there are few of the metallurgical men with structural training." The bridge mentioned in this paragraph is a small wooden footbridge spanning a narrow waterway and was so insignificant that it did not receive the dignity of a design from the drafting room, but was built in a day or two by carpenters.

The article implies that the pipe line for the Butte Water Co. is the only large engineering undertaking in this vicinity. This is certainly a notable event in engineering. At the same time the Anaconda company has, each year for the past six years, spent as much money on new work as this pipe line cost and several of the enterprises have been new and unique in the engineering world. W. C. CAPRON,
Mechanical Superintendent Anaconda Copper Mining Co.

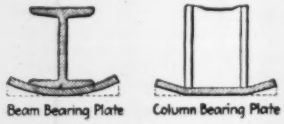
Anaconda, Mont., Dec. 17, 1920.

[There was no intention of slighting the work of the Anaconda Copper Mining Co. in the article referred to; in fact there is a tribute to the engineers of that and other of the mining companies in the Butte district. Their activities, however, are more in the field of the mining engineer. It is notoriously difficult to distinguish between the different kinds of engineering. Mr. Capron's letter only confirms this.—EDITOR.]

Different Formulas for Beam and Column Bearing Plates

Sir—Referring to R. W. Bowman's letter on bearing-plate formulas, p. 1105 of the Dec. 2 issue, and your editorial comment thereon, the following points relative to the application of the formulas occur to the writer:

For plates under I-beams the distribution of pressure over the bearing area of the beam flange is approximately uniform, due to more or less "flexibility" of the flange. In this case the Carnegie formula applies. This is especially true of girder beams having wide and thin flanges. Its use is on the side of safety.



FLEXURE OF BEARING PLATES

For base plates under columns, on account of the "inflexibility" of the column shaft, the load is not uniformly distributed and the Bethlehem formula properly applies. Use of a thicker plate to care for bending moment would seem to be unnecessary; however, where there is a possibility of corrosion, as is often the case, the thickness should be made greater than theory requires. WALTER J. FUSTON,
Dallas, Tex. Fuston & Van Valkenburgh,

Hooped Columns and Construction Joints in the Galveston Fire

Sir—In your issue of Dec. 2, p. 1101, Edward Godfrey has evidenced much interest in the results of the fires in the warehouse at Galveston, Tex. Mr. Godfrey states his opinion that "it is inconceivable that anything approaching this destruction could have occurred if the columns had been reinforced with close-spaced hooping." After closely examining the original photographs, three of which were not published by you, the surfaces of columns in the lower story which spalled off reveal a comparatively close-spaced hooping, approximately 3 in. on centers, and the hooping of columns supporting the roof about 6 in. on centers. The columns of the lower story show the same tendency, and actual failure in some cases, as did the columns with spirals about 6 in. on centers. If the upper story columns failed first it is natural to believe that the impact from the dead weight of the roof slab would cause an unfavorable condition of loading on the lower story columns; otherwise, if the design of all columns was uniformly proportioned with relation to unit stresses and the loads imposed, it appears from the results that in resistance to fire the spirals spaced 6 in. on centers compare favorably with those spaced 3 in. on centers.

In the absence of tangible evidence the writer would concur with Mr. Godfrey's theory, but the facts in this instance do not substantiate his conclusion. In all cases where columns remained, the spalling did not extend farther than the hooping which was left exposed. This condition of spalled-off column surfaces also prevailed in several cases in the compartment which did not fail.

Mr. Godfrey appears rather lenient in his conclusion regarding the effect of fire on construction joints. The photograph reproduced on page 983 of your issue of Nov. 18 unfortunately does not show the detail displayed by the original photograph. In the compartment that survived the fire the surface of floor slab revealed no indication of irregularity except at construction joints, although the distance between these joints and the exterior walls or expansion joint is considerable. The construction joints at the center panels offered the only opportunity for the excessive heat to attack the slab rods along the plane of maximum positive moment and hence produce elongation of these rods and subsequent distortion due to heat and stress from dead and live loads. This experience indicates the usual construction joint to be the most susceptible source of weakness in a reinforced-concrete building.

As Edgar A. Cross states in your issue of Dec. 2, p. 1102, the value of tension rods when subjected to heat even as low as 250 deg. C., or 482 deg. F., is greatly lessened. The expansive force due to heat is naturally cumulative, but the spandrel walls and expansion joints, being the points of least resistance, would hardly occasion the buckling of slabs if the present form of construction joints did not offer a direct medium for weakness and failure in the event of fire.

St. Louis, Dec. 17. W. J. KNIGHT.

City Must Pay Engineer's Fee for Services

The Superior Court of the Province of Quebec has ruled that the city of St. John, P. Q., must pay Royal LeSage, consulting engineer, Montreal, for plans, specifications and estimates prepared by Mr. LeSage for sewers for the city named. The city abandoned the project after having authorized the work and a bond to the amount of $50,000. Mr. LeSage presented a bill for $2,500 and the city denied liability, according to *The Canadian Engineer*, but offered $500 in settlement. It was shown by Mr. LeSage that his traveling expenses and other disbursements amounted to $725. The court decided that Mr. LeSage was entitled to 3 per cent for the preparation of plans and to 2 per cent for having been deprived of the supervision of the construction work. It was also decided by the court that the engineer was entitled to costs.

NEWS OF THE WEEK

New York, December 30, 1920

Erect Large Alaskan Bridge in Winter

Span of 504 Feet Under Way—To Erect Steel Arch Next Summer by Hell Gate Arch Method

The railroad being constructed by the Alaskan Engineering Commission has reached the Susitna River crossing, 260 miles from Seward, and on Dec. 1 more than 50 per cent of the steel in the bridge at that point had been put in place. This bridge is being built during the winter largely because piles could be driven only a few feet at the site and it was feared that high water in the summer would menace falsework built on piling of that sort. The structure as a whole consists of 392 ft. of trestle, two 70-ft. timber pony trusses, two 121-ft. Howe timber trusses and a 504-ft. steel span. The latter is a Baltimore truss, designed for a loading of two E50 locomotives followed by a uniform load of 4,000 lb. per foot. It has a center height of 76.75 ft. and a total weight of 1,650 tons.

Contract for the structure was awarded early in February, 1920. The designs were completed and spans assembled and shipped by July. Modjeski & Angier, as consulting engineers, approved detailed designs of the bridge prepared by the American Bridge Co., which, in turn, were based on the general plans of the Alaskan Engineering Commission. The bridge work and all other construction on the Alaskan railroad is under the supervision of Col. F. H. Mears, chairman Alaskan Engineering Commission.

The completion of the Susitna bridge this winter will make it possible to carry on work on a large two-hinged arch across Hurricane Gulch, 20 miles farther on, during the open season next year. The arch span in this structure will be 384 ft. long. At its center the rails will be 330 ft. above the bottom of the gorge. The plan of erection decided upon calls for the use of backstay anchorages, similar to those used in erecting the Hell Gate arch in New York. This bridge is being designed for E60 loading. With the steel approach spans, which total 530 ft. in length, t will require 1,300 tons of steel.

Saskatchewan Licensing Bill Fails of Passage

The bill for the incorporation of the Association of Professional Engineers of the Province of Saskatchewan, Canada, failed of passage by the Legislature when it came before that body this month.

Engineering Council Holds Final Meeting

The final meeting of engineering council held in Washington, D. C., Dec. 16, was almost entirely devoted to the closing of council's affairs. Unfinished business and uncompleted projects were transmitted to the United Engineering Society with the suggestion that they be referred to the new American Engineering Council with favorable recommendation. The principle action of a continuing nature taken by council was the adoption of the resolution to the effect that the present financial stringency and the prospect that federal revenues during the next year will not equal the government expenses, make it a matter of good citizenship for every considerate person to avoid advocating expansion of government activities; that in consequence of this belief, Engineering Council would endeavor to set the example by withdrawing its previously enlisted support of efforts to secure increased appropriations for certain government engineering projects.

To Give Up Boston Garbage and Refuse Disposal Contract

The Boston Development & Sanitary Co., which has a ten-year contract for the disposal of the garbage, ashes and rubbish of Boston, expiring July 1, 1922, has notified the city that it must discontinue its services on Dec. 31, 1920, on account of the losses that it is sustaining. These losses are attributed to the increase since 1912 in the cost of labor from 17½ to 60c. an hour and of coal from $3.80 to $14 a ton; the decrease in the price of grease from about 5c. to a quotation of 3c. a pound but with no market; and to the failure of the city to enforce the contract provisions for the separation of garbage and ashes. Had this separation been effected, the company states it could have continued to operate its contract without loss. A few months ago the company offered to pay the city the amount of its surety bond, $100,000, if the city would cancel the contract. Since then it has offered to continue the disposal work if the city would pay operating costs, without profit to the company or executive salaries. These offers the company states the city has virtually rejected. It is supposed that the city will begin operating the plant on Jan. 1 and take action against the company for non-fulfillment of its contract. The contract price for 1920 is $152,000; for 1921, $156,000; and for the half year ending June 30, 1922, $80,000.

Engineers on General Staff Eligible List

Twenty-one Regulars and Nineteen Ex-Service Men Included by Pershing Board in Roster of 607 Names

Engineers to the number of 40, of whom 21 are regulars and 19 reserve officers, members of the National Guard, or civilians formerly in the military service, are included in the General Staff eligible list of 607 names made public last week by the War Department as General Order 74. The list is published in compliance with Section 5 of the National Defense Act, approved by Congress June 4, 1920, which requires a board consisting of the general of the army, the commandant of the General Staff College, the commandant of the General Service Schools and two other general officers of the line, chosen by the Secretary of War, to select those officers of the Regular Army, National Guard, Officers' Reserve Corps and others who demonstrated their fitness for General Staff duty during the World War, who are considered qualified by "education, military experience, and character," for General Staff duty. The board was headed by General Pershing. From now on, no officer can be detailed for General Staff duty unless his name appears on the eligible list, which is popularly referred to as the "Blue Book" of the Army.

Among the Engineer regulars on the list which follows are Brig.-Gen. W. D. Connor, who served in France as commander of the Port of Bordeaux, chief of staff for Major General Harbord, commanding general, S. O. S., later succeeding him in that post, and then being placed in command of the American Forces in France after the return of General Pershing to the United States; Col. (formerly Brig.-Gen.) Edgar Jadwin, who served in the A. E. F. as director of construction and forestry, in charge of practically all the engineering work in France outside of the zone of the armies; Col. (formerly Brig.-Gen.) Sherwood Cheney, who was chief of the Army Transport Service abroad, and Major, (formerly Col.) W. T. Hannum, who was a General Staff Officer (G.-5) specializing in the training of troops. Col. Mason M. Patrick, who was chief of the Air Service in France, with rank of major general Col. E. D. Peek, who commanded a light railway regiment abroad; Col. George R. Spalding, who was chief engineer of the First Army; Col. James A. Woodruff, who was assistant to Gen. Jadwin, director of construction and forestry, and Col. G. A. Youngberg,

who served on the G-4 Section of the General Staff at Chaumont.

Of the engineer officers assigned to duty in the United States were Brig.-Gen. Henry Jervey, assistant chief of staff and director of operations; Col. (formerly Brig.-Gen.) H. B. Ferguson, commanding port of embarkation; Col. Lytle Brown, General Staff, and others.

Of the civilians, Major Barber was among the first Engineer officers in France, having gone there as a member of the Railways Commission sent at the request of General Joffre. Brig.-Gen. R. C. Marshall, Jr., was chief of the construction Division of the Army, while Lieut.-Col. John P. Hogan served with G-2, Second Army, A. E. F. Col. John F. Sewell was Section Engineer and commanding officer of the 17th Engineers at St. Nazaire in France, while Col. Joseph Hyde Pratt commanded a divisional engineers regiment.

The following engineer officers' names are contained in the General Staff list:

Regular Officers — Brown, Lytle, Col.; Cheney, Sherwood, Col.; Connor, William D., Brig.-Gen.; Emerson, Thos. H., Major; Ferguson, Harley B., Col.; Hannum, Warren T., Major; Harts, William W., Col.; Jadwin, Edgar, Col.; Jervey, Henry, Brig.-Gen.; Kelly, William, Lieut.-Col.; Kingman, John J., Major; MacArthur, Douglas, Brig.-Gen.; Patrick, Mason M., Col.; Peek, Ernest D., Lieut.-Col.; Sherill, Clarence O., Lieut.-Col.; Spalding, George R., Lieut.-Col.; Steese, James G., Major; Ward, Ralph T., Major; Watkins, Lewis H., Major; Woodruff, James A., Lieut.-Col.; Youngberg, Gilbert A., Lieut.-Col.

Civilians—Barber, Alvin B., civilian, formerly Col.; Boesch, Clarence E., Major, R. C.; Bright, Graham B., Major, R. C.; Dasher, Charles L., civilian, formerly Major; French, Herbert W., civilian formerly Capt.; Hogan, John P., civilian, formerly Lieut.-Col.; Lightner, George C., Major, R. C.; Low, John C., civilian, formerly Lieut.-Col.; Marshall, Richard C., Jr., civilian, formerly Brig.-Gen.; Pill, Leon M., Major, R. C.; Poole, John H., Col., R. C.; Pratt, Joseph H., Col., R. C.; Roberts, Spencer, civilian, formerly Major; Sewell, John S., Col., R. C.; Shaughnessey, Edward H., Col., R. C.; Taylor, Roy, civilian, formerly Major; Whitehurst, Herbert C., Major, R. C.; Williams, Edward H., Col., R. C.; Wilson, William J., Major, R. C.; Woodruff, Edwin D., Major, R. C.

Tacoma Pier Nears Completion

The Port of Tacoma, Wash., will issue $60,000 of warrants bearing 6 per cent interest in order to complete its port project to the point where Pier 1, the open pier, can be placed in commission. The funds will be used in laying railroad tracks to the new pier, purchase of a big crane and other improvements.

Quartermaster Wants $20,700,000 for Construction

The sum of $20,700,000 is asked of Congress by the Quartermaster General, U. S. Army, to be used in the construction, during the next fiscal year, of barracks, quarters, stables, storehouses, magazines, administration buildings, sheds and shops. The appropriation for similar purposes during the current fiscal year was $8,500,000. In addition, $3,500,000 has been asked for the construction and repair of roads, walks, wharves and drainage channels and $1,509,000 for the construction and repair of hospitals.

Materials Handling Section of A. S. M. E.

With the purpose of formulating a definite program for the section, its executive committee is seeking the suggestions of the members of the section and of the society.

The scope of the work is covered by the two following questions:

(1) How the mechanical engineers can improve machinery and equipments for the handling of materials.

(2) How great the material handling costs can be reduced if the whole subject of transportation is analyzed and co-ordinated from the viewpoint of making economies over our present method.

The appointment of subcommittees is being considered along two distinct lines: (a) According to types of material handling equipment, such as conveyors, cableways, cranes, etc. (b) According to industries which have material handling problems, such as steel manufactures, storage warehouses, commodity distribution centers, construction work, automobile or tire industries, etc.

It is the intention of the section to so thoroughly discuss the controlling factors in each line by meetings held by these various subcommittees so as to develop better methods of handling materials and to standardize equipment and methods where that is desirable.

It is suggested that important research work might be undertaken to build up through the formation of specialized committees certain classes of data and of information of general interest to all members. Such classes of data pertain, for example, to the handling of materials at the terminals, the relation of costs of material handling to the general costs of factory operation, and the percentage of costs of commodities which merely represent transportation in its various phases.

A questionnaire is being sent out aimed to bring out the ways in which the material handling section can interest the members and can best serve the purpose for which the section has been organized. The office of the section is at the society headquarters, 29 West 39th St., New York City.

Hetch Hetchy Project Visited by U. S. Army Engineers

While on a western tour preparatory to making recommendations for the annual appropriations, the Board of Engineers for Rivers and Harbors, Corps of Engineers, U. S. A., made an inspection trip over the Hetch Hetchy project as guests of M. M. O'Shaughnessy, city engineer of San Francisco. Among the visiting engineers were Brig.-Gen. Harry Taylor, assistant Chief of Engineers, Cols. J. C. Sanford, Charles Keller, Wm. B. Ladue, J. C. Oakes, and Herbert Deakyne, Majors C. S. Ridley and U. S. Grant 3rd.

Railroad Regiment Authorized

Instructions have been issued by the Chief of Engineers, U. S. Army, for the organiation of the 16th Engineers, a railroad regiment. This is the first time that engineer officers and troops specializing in railroad construction will be concentrated in a single organization in peace time. Only a battalion is to be formed at present, but it will serve as a nucleus around which the organization can be expanded in case of necessity.

Urge Uniform Traffic Regulations

What started as a meeting of the executive committee of the International Traffic Officers' Association, at Cleveland, Dec. 7, developed into a National Conference on Highway Traffic Regulations which will meet in Washington Jan. 10 to reach final agreement on traffic regulations which can be presented with their endorsement to the country at large and particularly to the 42 state legislatures convening next month. A temporary organization of the National Conference on Highway Traffic Regulations was effected by the representatives of 15 national and 3 other associations who had been invited to give their ideas on the subject.

The conference of eighteen associations elected as their temporary chairman, Charles M. Talbert, director of streets and sewers of St. Louis; vice-chairman, Harry Meixell, Jr., secretary, Motor Vehicle Conference Committee; secretary-treasurer, David R. Faries representing the Automobile Club of Southern California; and assistant secretary and treasurer, Sidney J. Williams, secretary and chief engineer of the National Safety Council.

The National Conference on Highway Traffic Regulations is not a new body, but a consolidation of all existing organizations which are interested in standardizing traffic legislation and regulation. For years there has been a great duplication of efforts in the agitation for a national traffic code and there are now at least four proposed standards for such a code.

"Once a uniform traffic motor vehicle law is adopted," said Mr. Talbert "the next logical step will be standardization of traffic signs and signals and this will naturally lead to uniformity in administrative and judicial practice."

The feeling expressed at the Cleveland conference was that the standardization of vehicle laws is becoming more and more imperative. It is estimated that there are in the cities of the United States approximately one million arrests for traffic law violations each year and records at the headquarters of the National Safety Council indicate that a very large proportion of the 12,000 fatalities and hundreds of thousands of injuries caused by automobile accidents each year result from violation of traffic laws, in many instances from ignorance of such laws as are in force.

To Vote on Kittitas Irrigation Contract in Washington

Property owners under the proposed Kittitas high line irrigation project, designed to irrigate approximately 73,000 acres of land in the vicinity of Ellensburg, Wash., will shortly vote on the acceptance of a contract, approved by Secretary of the Interior Payne, providing that the Government furnish storage water necessary for the project.

Would Put Kansas Water Resources Under One Head

A State Water Congress was held Dec. 15 in Topeka, Kan., for the purpose of discussing a proposal to consolidate the administration, investigation and utilization of the water resources of the state under one head, the Division of Water Resources to be created within the Court of Industrial Relations. At present six state organizations having to do with water resources now work more or less independently. They are the Court of Industrial Relations; the Kansas Water Commission; Division of Irrigation with the Department of Agriculture; State Executive Council; State Geological Survey and State Board of Health.

The Industrial Relations Court issues permits through the Public Utilities Commission, values and controls rates and service of hydroelectric properties. The technical services would be handled by the proposed division of Water Resources. The duties of the Kansas Water Commission are to investigate and control the problems of flood prevention, drainage, domestic water supply, water power navigation and irrigation. It maintains river gaging stations and co-operates with the U. S. Geological Survey. The commission is to be abolished and its duties transferred to the proposed division. The State Irrigation Commissioner gathers irrigation statistics and operates by lease state-owned irrigation plants.

The Division of Irrigation within the State Board of Agriculture is to be abolished and its duties enlarged and transferred to the proposed division. The State Executive Council administers the "Sand Law" which relates to the sale and taking of sand, or any natural product from the river beds or state-owned property. The duties would be assumed by the proposed division. The State Geological Survey makes surveys of underground water surveys and would continue the work in co-operation with the proposed division. Likewise the State Board of Health would continue to function in handling sewage and water-works problems but would at all times co-operate with the new division.

In the discussions the few opponents to the plan argued for home rule and against corporation control which was considered easier of attainment under state commissions. More rapid and complete development of the state's water resources was considered possible under the proposed division.

A committee of five to represent all interests involved was authorized to co-operate with the governor and the Water Commission in drafting the proposed bill.

Report Withholds Recommendation on Imperial Valley Work

No specific recommendation as to the best method of proceeding with the irrigation of the Imperial Valley in California can be made until an examination of the Boulder Canyon dam site is completed. This statement is made by the Secretary of the Interior in submitting a report to Congress.

ARCHIBALD BYRON LUEDER

The report goes exhaustively into the details of the irrigable area and the location of the holdings which are to be benefited. The whole matter hinges on the possibility of constructing a large reservoir in Boulder Canyon, near the northern boundary of Arizona below the mouth of Virgin River. The report points out that a basin of large capacity could be obtained if a high dam were constructed. The investigation thus far, however, has not shown favorable foundation conditions for such a dam.

In case the Boulder Canyon reservoir does not prove to be feasible or is not constructed an alternative proposition provides for the construction of the Dewey reservoir on Grand River, together with the necessary canals and power houses. The total expense of the latter project is estimated at $67,269,000.

The report calls attention to the fact that if all possible development on the upper rivers and tributaries is carried out and storage provided only in the Dewey reservoir there will be some shortage of water on certain lands in two years out of twenty-one, judging from past records.

Archibald Byron Lueder

The roving life a construction engineer must lead cannot be better told than by recounting the chronology of the career of Archibald B. Lueder, M. Am. Soc. C. E., who was one of the best exponents of that branch of the profession, and who died Aug. 21, 1920. His work took him to practically every corner of the globe.

Mr. Lueder was born at Nanticoke, Pa., Aug. 26, 1876. He graduated from the College of Civil Engineering of Cornell University in 1899, at which time he started as timekeeper upon construction work with the Berlin Iron Bridge Co. of East Berlin, Conn. After serving for a time as foreman of erection with this company, he was sent in the spring of 1901 by the American Bridge Co. as agent and assistant engineer on the construction of twenty-eight viaducts and bridges on the Uganda Railway in British East Africa, Port of Killandini. Most of the work was done with native laborers who had had no experience in steel work.

Returns to America

Upon the completion of this work, he returned to America in the spring of 1903 and was employed by the American Bridge Co. as assistant engineer upon the construction of a number of bridges in various parts of the country.

In February, 1909, Mr. Lueder joined the Merrill Ruckgaber Co. and continued with this company until December, 1912. The work under his supervision included steel and concrete highway bridges and concrete sewer on Broad St., Stapleton, S. I.; some difficult sewer construction in Brooklyn and the construction of Evitts Creek reservoir and dam at Cumberland, Md., which included 9 mi. of wood stave pipe line.

In December, 1912, Mr. Lueder was superintendent for the Arthur McMullen, Snare & Triest Co. on the 125th St. section of the Lexington Ave. (New York) subway, and after this work was well under way he was sent by Snare & Triest to Conquimbo, Chile, in charge of the construction of ore docks for the Bethlehem Steel Co.

Returning from Chile during the spring of 1915, he was first employed by the Jarrett-Chambers Co., and later by the Phoenix Construction Co. on a power plant at Omaha, Neb.

Mr. Lueder was connected with the Electric Bond & Share Co. as manager of construction in the summer of 1916 until early in 1919, the power plant jobs of which he had charge during this time being located at Omaha, Wichita and Fort Worth.

The year 1919 was devoted to the development of oil properties near Fort Worth, Texas. Mr. Lueder was president of the Phoenix Oil Co., which he organized and managed until it was necessary for him to give up his work because of ill health which developed early in 1920.

New Railroad for Quebec

A new line of railroad 120 miles long, from Chicoutimi to St. Felicien, via the north side of Lake St. John, is provided for in a contract that has been signed between the Government of the Province of Quebec and the Quebec & Chibougamou Railway Co. The new line will run through timbered country. A large amount of the material has been contracted for and the road is to be completed in two years.

Colorado May Not Build Tunnels

A constitutional amendment authorizing Colorado to construct three tunnels through the mountains, and also authorizing the issuance of bonds for the work, was defeated at the election of Nov. 2. In view of this result a movement is under way now to bring before the legislature in January another proposal to construct the tunnels. The method by which the work can be undertaken has not yet been decided upon. Favorable consideration is being given to the plan of authorizing (by legislative enactment) the formation of tunnel districts similar to irrigation districts, any district then to vote on the question of bonding itself for the tunnel construction. This plan would make it possible to finance a tunnel on the credit of those sections of the state that would be most directly benefited, without reference to other parts of the state.

High Dam Proposed for Merced Irrigation District

A report on the requirements of the Merced irrigation district in the San Joaquin valley of California, together with recommendations for the development of the necessary storage, canal systems, drainage, etc., has just been submitted to the district by John D. Galloway, civil engineer, of San Francisco. The district, formed about a year ago, contemplates the irrigation of 200,000 acres of fertile land, of which 52,000 acres is already irrigated. Plans are under way for a bond election to secure funds with which the proposed work may be carried out.

The work recommended by the report would include a storage reservoir on the Merced River formed by a dam at Exchequer, 7 mi. above Merced Falls. At this site, the report states, there is a favorable site for a simple arch dam of perhaps 330 ft. total height, which would raise the water 300 ft. and form a reservoir 12 mi. long. This would necessitate the relocation of 20 mi. of the Yosemite Valley railroad which now runs through the reservoir site. It is proposed to locate a 20,000-kw. power plant at the foot of the dam, part of the energy from which would be used for pumping within the district. The plans contemplate the purchase of the Crocker-Huffman canal system and the addition of mains and laterals to make a total length of about 850 miles of canal.

Small Mine Shares Proposed for German Workers

A feature of the plans now under consideration in Germany for the socialization of the coal mines is the proposal to give the employed miners as well as officials the option to take shares in the mine properties and to issue for this purpose shares of a small nominal value, that is 100 marks, whereas up to now shares of the German joint stock companies had a minimum face value of 1,000 marks. The mine owners, led by Stinnes, are fighting with all their power and vast influence for the maintenance of the present proprietorship conditions and to avert the danger of the expropriation they have been willing to make an important concession by providing a limitation of the share dividends. By this concession, and by the participation of the working classes in the proprietorship and other betterments promised them, it is hoped to defeat the expropriation advocates.

Would Withdraw Park Lands From Federal Power Act

A number of amendments to the Federal Water Power Act, signed by the President last June, have been introduced in the present session of Congress, but most of them are in regard to routine matters. One of them, however, is of radical nature. This is S. 4554, introduced by Senator Jones, of Washington, which provides that no water-power development may be made under the act within the limits of a national park or national monument. The amendment reads as follows:

> That hereafter no permit, license, lease or authorization for dams, conduits, reservoirs, power houses, transmission lines or other works for storage or carriage of water, or for the development, transmission or utilization of power within the limits of any national park or national monument, shall be granted or made without specific authority of Congress, and so much of the act of Congress approved June 10, 1920, entitled "An act to create a Federal Power Commission, to provide for the improvement of navigation, the development of water power, the use of the public lands in relation thereto, and to repeal Section 18 of the river and harbor appropriation act approved Aug. 8, 1917, and for other purposes," as authorizes licensing such uses of national parks and national monuments by the Federal Power Commission is hereby repealed.

Comprehensive Road System Proposed for Saskatchewan

A plan to provide the Province of Saskatchewan with 1,067 miles of paved roads suitable for automobile traffic, by connecting up the more thickly populated centers, has been evolved by Commissioner Forath. The total estimated cost of construction of the suggested roads is $24,000,000 provided the roads are constructed as near as possible to railways and the work is so organized that it can be carried on continuously and as rapidly as possible. In the main, the commissioner's scheme is to construct a 15-ft. paved strip on all the main roads in the Province, the cost of which is to be recovered in the course of from 10 to 20 years by a system of tolls.

Indictment of Plumbers Follows Lockwood Investigation

Indictment of fifty-two members of an alleged plumbers "ring," maintained to defeat competitive bidding; the existence of an alleged combination that dominate the cast iron pipe field; and the promise of two of the three trade associations under fire from the Lockwood joint legislative committee on housing to "mend their ways" by returning to a competitive bid basis, are the high lights in the past week's work of the Lockwood committee, investigating the housing situation in New York City.

The fifty-two members of the alleged plumbing "ring" included twenty-seven corporations and twenty-five individuals, all members of the so-called Hettrick "code of practice" group. The indictment against them is a violation of the Donnelly anti-trust law. Hettrick, previously indicted, was again included among the indicted plumbers, and his $100,000 bail was continued. The plumbers appeared for arraignment, pleaded not guilty and were released under bail of $5,000 each.

Cast Iron Pipe Combine

The existence of a cast iron pipe combine, which fought legislation and plumbing innovations designed to save the building public thousands of dollars annually, was disclosed through the testimony of Charles F. Tuttle, a professional secretary, who had acted in that capacity for the Eastern Soil Pipe Association, the American Institute of Lead Manufacturers, and other trade organizations. His examination revealed the existence of an organization of ten pipe concerns, known as the Eastern Soil Pipe Association, working in conjunction with the Southern Soil Pipe Association. It was brought out in Tuttle's examination that the Central Foundry Co., the largest of the Eastern concerns, made all the discount prices for the other organizations, a practice that continued up to June 2, 1920.

The two trade associations that promised to return to a basis of competitive bidding are the Stone Mason Contractors' Association and the Composition Roofers' and Waterproof Association. The former association agreed to return at once to a basis of competitive bidding and the latter to eliminate from its practices "objectionable regulations," the chief one being a rule that prevented roofers from guaranteeing a composition roof for more than two years, when a guarantee for ten years was possible. According to the testimony of E. J. Lee, the roofers' association secretary, the Johns-Manville corporation was barred from membership because it guaranteed composition roofs for ten years. Included in the "reformation" of the stone masons' association, it was stated, would be the abrogation of an agreement that the association had with unions workers, whereby no union mason could work for a contractor not a member of the association.

Insurance Companies Lend Large Amounts to Aid Housing

According to Haley Fiske of the Metropolitan Life Insurance Co., New York City, life insurance companies of the United States, for the first ten months of 1920, loaned more than $230,000,000 on city and farm real-estate mortgages. The insurance companies have $2,082,000,000 invested in bonds and mortgages throughout the country, almost equally divided between farms and cities. Commitment for many millions more have been made, one company alone having promised approximately $50,000,000 in loans not yet closed. A great deal of this money loaned, it is pointed out, was used to aid housing propositions.

Wage Decrease Accepted by Textile Unions Under Protest

Nine of ten textile unions of New Bedford, Mass., recently voted to accept under protest, a 22½-per cent reduction in wages, rathen than strike. The tenth union voted to strike. Approximately 35,000 operators are affected.

Wage reductions among the textile workers were also noted in other sections of New England, according to press reports. At Fall River a wage reduction of 22½ per cent for the 35,000 cotton mill operatives in that city was announced Dec. 22 at a conference between the Fall River Cotton Manufacturers Association and the Textile Council. The reduction will become effective on Jan. 3 in all of the 100 mills controlled by the members of the association. Wage cuts of 22½ per cent in Holyoke and Boston were also announced. The Manufacturers Association of Boston recently announced that the decrease would occur and that the piece-work system of payment would be restored.

The Stanley Iron Works of Bridgewater, Mass., whose head offices are in New Britain, Conn., recently posted a notice of a 15 per cent reduction in wages, effective at once. The 5 per cent monthly bonus is also abolished and a drop from time and a half to straight time for all overtime is announced.

The directors of the Loyal Legion of Loggers and Lumbermen for Oregon has announced a cut in the minimum wage for legion workmen of 80c per day, making a new minimum wage of $3.60. Approximately 2,000 employees of a manufacturing establishment in Chicopee, Mass., announced a 22½-per cent reduction, beginning Jan. 10. The same reduction will be put into effect by two establishments in Sanford, Me., a week earlier, affecting 3,000 operatives. A wage reduction affecting more than 700 employees was announced recently by the Parkersburg Iron Co. of Parkersburg, W. Va. In order to save sixty of their number from being laid off, a proposal that 450 employees of the Great Northern R.R. Co. at Great Falls, Mont., each work shorter hours, has been made by the men themselves in a communication sent to the Great Northern headquarters in St. Paul. The sixty men were laid off Dec. 21. A Chicago hotel has announced a 20 per cent decrease in waiters' wages for the first of the year, other hotels contemplating the same thing.

Construction Company Makes Winter Provision for Old Employees

The Cement-Gun Construction Co., Chicago, Ill., facing inaction during the winter and unwilling to see its regular employees go jobless, has devised a plan which it recently propounded to its regular employees. The company is equipped to make concrete septic tanks during warm weather but not during winter. The plan involves fitting up the tank plant with heating apparatus for winter work, allowing regular employees to be given the chance to work at a reasonable wage, and to share in the profits resulting from the sale of the tanks if a market for those manufactured during the winter is found in the spring and summer. Acceptance of the proposition is entirely optional with the employee, and his non-acceptance does not injure his status with the construction company.

Lumber Production 60 Per Cent of Normal

According to a recent bulletin issued by the National Lumber Manufacturers Association, production of lumber is now about 60 per cent of normal. Shipments closely approach production so that the volume of stock is not substantially increasing. It is expected that further reduction in output will occur in the next few weeks through the closing of more mills in the South and West. However, the bulletin points out, the resumption of building early in 1921, it is believed, must result in an active demand on the sawmills, and operators for the most part are optimistic. The bulletin also says that hundreds of sawmills in the principal producing regions are making sales at prices at, near, or even below cost of production. The move is made in an effort to maintain organizations intact.

Original Road Tender Cut $35,000 in Readvertisement of Bids

According to information just received from the Alabama Highway Commission, a contract has been awarded to W. T. Taylor, Talladega, Ala., for grading and installing drainage structures on 18.2 miles of state highway, at a price $35,000 under the same contractor's bid submitted Nov. 10. At that time bids were advertised on the project, but, though several contractors bid, the state highway commission considered the bids excessive, readvertising on Dec. 21 with the above result.

Railroad Officials and Trainmen Discuss Labor Situation

Official representatives of the 50,000 union trainmen employed on the Pennsylvania R.R. recently consulted, at the invitation of President W. W. Atterbury, with operating officials of the Pennsylvania system upon methods of avoiding strikes and improving the general service of the company. A decision was reached by both officers and operatives to co-operate in the building up of machinery for the settlement of labor disputes over the entire system. The railroad was represented at the conference by virtually all the vice-presidents, general managers and general superintendents from all regions of the system. Approximately 300 official representatives of the union operatives, representing the four big union railroad bodies, were also present.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. 19-20, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

ENGINEERING INSTITUTE OF CANADA, Montreal; Toronto, Feb. 1-3.

The Nashville Engineering Association, at its meeting Dec. 14, elected the following officers: President, F. E. Freeland; vice-president, C. M. Darden; second vice-president, Wilbur Nelson.

The Ottawa Branch, Engineering Institute of Canada, at its meeting Jan. 6 will be addressed by J. M. R. Fairbairn, chief engineer, Canadian Pacific Ry. The members were addressed, Dec. 16, by W. H. Boyd, chief topographer, Geological Survey of Canada on topographical surveying.

The Cleveland Engineering Society, at its noonday meeting, Dec. 31, will be addressed by Lieut.-Col. P. S. Bond on "The Engineer and His Relation to National Defense."

The Engineers' Club of Philadelphia, at its Jan. 7 meeting, will discuss "The Development and Future of Handling Freight by Motor-Trucks." The subject of the Jan. 21 meeting will be "Symposium on Hydro-electric Power and Distribution."

The Engineering Society of Wisconsin will hold its annual meeting at Madison, Wis., Feb. 11-12. Secretary, Leonard S. Smith.

The Indiana Engineering Society will hold its annual meeting at Indianapolis,

Ind., on Jan. 27-28. Charles Brossman, Merchants Bank Building, is secretary.

The Technical Club of Madison, Wis., at a recent meeting passed a resolution urging upon President-elect Harding the appointment of Herbert C. Hoover as Secretary of the Interior.

The Highway Engineers' Association of Missouri will hold its annual meeting at the Planters Hotel, St. Louis, Mo., Jan. 6, 7, 8, 1921.

The Kansas Engineering Society, at its annual meeting, Dec. 16-17, elected the following officers: President, Dean P. F. Walker of the University of Kansas; vice-president, Lloyd B. Smith; secretary-treasurer, J. M. Averill.

PERSONAL NOTES

CHARLES E. SLOAN has been appointed city engineer of Manteca, Cal.

FRED H. SCHRIEBER, formerly assistant state highway engineer of South Dakota, has been appointed state highway engineer to succeed F. S. Peck, resigned.

W. G. STROMQUIST has left the U. S. Public Health Service to accept the position of sanitary engineer with the health department, Memphis, Tenn.

GEORGE G. TYRRELL, formerly with the Missouri State Highway Department, has been appointed resident engineer on the construction of federal-aid roads for the Mississippi State Highway Department.

W. H. FAIRCHILD has resigned the position of city engineer to become general manager of the Public Utilities Commission, Galt, Ont., Canada.

THOMAS N. JACOB has been appointed chief engineer of the East Side Levee and Sanitary District, East St. Louis, Ill. Elmer R. Rodenberg has been appointed resident engineer and J. E. Weinel, field engineer.

BURDETTE WOODYARD has resigned the position of highway engineer of Wood County, W. Va.

S. R. BATSON has resigned the position of highway engineer for Jefferson County, Ala.

MORRIS FORMAN, formerly draftsman and estimator with the Miami Conservancy District, Hamilton, Ohio, has accepted a position as assistant drainage engineer, Winnebago County, Iowa.

ARTHUR I. HEIM has resigned his position with the State Highway Commission, Helena, Mont., to become office engineer for the Foote Engineering Co., Meridian, Miss.

ALEXANDER A. POMPER, formerly assistant engineer and inspector on municipal improvement work for the Spanish River Pulp and Paper Mills, Espanola, Ont., Canada, and recently junior engineer, Public Service Commission of New York, has been appointed assistant highway engineer, Monroe County, Mo.

JOHN H. CATON, 3D, formerly assistant general manager of the Industrial Chemical Co., Providence, R. I., has been appointed division engineer in the Bureau of Public Works, La Vega, Dominican Republic, engaged in the construction of the new road across the republic. Before the world war he was construction engineer in the Bureau of Public Works, Manila, and during the war was captain, 33d Engineers, and road engineer for Base Section 5 of the A. E. F. in France.

RICHARD ROBERTS, for the past five years employed in an engineering and executive capacity by the Guggenheim interests, has resigned to accept the position of sales engineer with the New York office of the Wayne Oil Tank & Pump Co.

LLOYD T. EMORY, civil engineer, of Philadelphia, is in British Guiana engaged in professional work.

GUS A. BRACHER has been appointed engineer of Washington County, Tex.

J. H. HOOPER has been appointed chief engineer of the Standard Steel Construction Co., Welland, Ont., Canada.

E. J. WIDMAN, formerly superintendent for the C. R. Cummins Co., Marysville, Mich., in charge of the erection of the power plant for the Detroit Edison Co., has been promoted to engineer in charge of work in the Detroit district.

J. M. HANNAFORD, after more than 48 years' continuous service with the Northern Pacific Ry., has retired from the presidency. He will continue as a director of the company.

OBITUARY

JOHN W. WOLFE, division engineer, Board of Local Improvements, Chicago, died Dec. 12. He was born in Ireland in 1870 and had lived in Chicago since 1885.

H. B. KELSEY, manager, The Foundation Co., Pittsburgh, Pa., died in New York Dec. 13.

JAMES P. DORAN, for ten years connected with the engineering department of the Eastman Kodak Co., died at Rochester, N. Y., Dec. 10.

E. V. SMITH, superintendent, Wheeling (W. Va.) division, Baltimore & Ohio R.R., died Dec. 8. He was born at Meadville, Pa. For several years he was connected with the Erie R.R., then entered the service of the Baltimore & Ohio R.R.

BUSINESS NOTES

THE AMERICAN FOREIGN STEEL CORPORATION announces its incorporation effective Jan. 1, 1921, for the purpose of doing a foreign and domestic business in iron and steel, steel products, coal, coke, pig iron, new and relaying rails. Main offices will be in the Woolworth Building, New York; foreign offices will be in Birmingham, England, and Rome, Italy. Plants will be located at Modena, Pa., Lackawanna, N. Y., and Jersey City, N. J., which were formerly operated by the Jos. Joseph & Bros. Co. Eli Joseph, for twenty years president of this company, will be president of the new organization. The Jos. Joseph & Bros. Co. will continue as proprietors of the Railway Supply & Mfg. Co., manufacturers of cotton and wool waste, and will continue their interests in the Ohio Falls Iron Co.

THE DETROIT STEEL PRODUCTS CO. has increased its capitalization to $5,250,000, and declared a common stock dividend of 300 per cent, thus distributing a portion of the company's surplus, which has accumulated during the last ten years. The management believes the time is opportune to strike an optimistic note, and at the same time to afford the stockholders control of their share of this surplus. During the existing dull period, everything possible is being done to give employment to employees, who would otherwise be idle, in a thorough overhauling of the plant and equipment so that increased efficiency may be isured.

THE ENGINEERING BUSINESS EXCHANGE, of which Charles Whiting Baker, formerly editor of *Engineering News*, is director, announces the opening of a Pacific Coast branch with James T. Whittlesey as director and with offices in the Claus Spreckels Building, San Francisco. This will make available to the engineers and engineering industries of the coast states the same service in bringing together the buyers and sellers of engineering and technical business properties that is being rendered by the New York office. Mr. Whittlesey for a dozen years was chief engineer of the Public Service Electric Co. of New Jersey. He built a number of that company's large power stations and developed a comprehensive ten-year program for the unification of the various plants and systems in New Jersey, which has since been closely followed. Since his removal to California eight years ago, he has been engaged in general consulting practice.

THE ALPHA PORTLAND CEMENT CO., Easton, Pa., has purchased three new properties—the Burt Cement Co. plant at Bellvue, Mich., the La Salle, at La Salle, Ill., and the Ironton Cement Co., Ironton, Ohio.